tanc bank, senses changes in of a d-c power supply to amplifier. Fast response, stat bandwidth and com- nd a ow drift level in respect mbient temperature and sup- and frequency, make it partic- ole w en it is used in conjunc- egu ing transformer feeding -filter supply system for a ng station.

on tc adar, this control is suit- wid field of other rectifier , including sonar, as well ent for proton acceleration. stem presently deal in d-c out- 10 300 kv and in power gh as 3,000 kw. The control ted to regulators of the step ay used in a wide variety ions here the output to be s dir current.

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: A IFIER CONTROL FOR LOAD- G EQUIPMENT, Bryan Webb, Jr., *AIEE Transactions*, pt. III (*Power Systems*), vol. 76, Dec. 1957, pp.

T NSFORMER CHARACTERISTICS, ttee port. *Ibid.*, vol. 68, pt. II, 5-11.

IVE STATIC RELAY CIRCUIT, John eding Special Technical Confer- nlin Magnetics and Magnetic AIE *Special Publication T-116*, . 15- 6.

ONIC TRIGGER, O. H. Schmitt. *entific Instruments*, London, England 1938, . 24-26.

Data Processing as a Tool for Generalizing Communications Systems

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AUTOMATIC data processing is a tool for transforming, processing, d calculating information. If one cepts this fact, one should be prepared describe the fundamental capabilities automatic data processing. Since mmunications is itself a tool, it is in- uctive to attempt to describe its funda- ental nature in a similar frame of refer- ce and compare the two. The results such a simple analysis lead to a view- int which has important implications system and equipment design.

The fundamental capability of data- cessing equipment can be described as e ability to transform information into ore desirable or useful forms. From e same viewpoint, the fundamental pability of conventional communica- ons equipment can be described as the ility to transfer information to a more esirable or useful location. Of course, om an abstract-logical viewpoint a ansfer is merely one special kind of ansformation, one in which only physical cation is changed. Combining these scriptions, one is led to the concept of a neralized data-handling system capable performing generalized transforma- ons, of which conventional one-location ata processing would be one special se and conventional no-processing data ansmission would be another special se. In such a system there would be no ndamental distinctions between data ocessing and data transmission, but only stinctions of convenience based upon plication, use, and design emphasis.

An examination of the information flow d manipulation in typical data-process- g and communication equipments shows most immediately that there is a very nsiderable mixture of functions going on both types of equipment. A consider- ble amount of the activity going on in- de any computer or data processor con- sts of simple transfers of information om one part of the processor to another.

At the same time within communica- ons equipment a major part of the ac- vity concerns generation, manipulation, d other processing of information used for control, supervisory, and error reduction purposes. In many cases nearly identical operations go on in both data-processing and communications equipments, with the differences, if any, being matters of design emphasis based upon application and use.

Is such a concept a reasonable one, and does it have any practical utility? The answer to the first part of this question will be examined in detail in this paper. Whether this concept has practical utility will be determined by the success in actual use of the equipment and system concepts it generates, which are receiving initial implementation in the FIELDATA family of equipments. These concepts are explained in this paper.

It is conventional to consider communications systems as consisting of three types of subsystems: subscriber, central-office, and transmission subsystems. The impact of automatic data-processing equipment, techniques, and concepts upon each of these three kind of subsystems will be illustrated by discussions of three topics:

1. The impact of data processors at subscriber locations, with particular emphasis upon the effects of processors upon the amount of communications required to meet user demands.
2. The impact of data processors on central office activities such as circuit of message switching.
3. The impact of data processing upon the design of data terminals which include transmission capabilities.

Impact of Data Processors at Subscribers' Locations

Experience to date shows that the introduction of data-processing equipment is often accompanied by an explosive increase in communications requirements. In part, this is due to the voracious appetite of data processors for current, up-to-date information in applications which take advantage of their abilities to process vast amounts of information economically. In part, it is because their tremendous speed of processing compared to the speed of human processors dramatically changes time factors in an over-all data-handling cycle.

For example, if a given report prepared by nonautomated techniques requires 45 days for its preparation, a delay of 3 or 4 days consumed in sending the raw data by mail is hardly noticed. However, if a data processor requires only one day to prepare the report from the raw data, this same 3- or 4-day delay in the mail becomes the overwhelming factor determining over-all report preparation time, and an obvious bottleneck. Clearly if the report is an important one, badly needed for effective planning, there is a strong tendency to demand better communications service to eliminate the bottleneck. Hence, considerable amounts of data once transferred by mail are frequency added to the electrical communications requirements.

This mushrooming of communications requirements is not, of course, an inevitable result of the adoption of data processing. On the contrary, one of the most attractive features of data processors to the communicator is their ability to process and reduce raw data to a more concentrated form, boiling out those portions which are irrelevant, redundant, or insignificant, so that the communications system and its human users need not be burdened. If a data processor is used to reduce data to one tenth of its raw form, it may then be used to reduce communications required to transmit that data by the same factor. Thus, data processors acting as data reduction devices located at an entry point of data into a communications system may be a particularly valuable tool for preventing large sources of raw data from overloading a communications system with excessive demands for service.

Of course, the same increased speed of processing by machines which disrupts the balance of many processing communications cycles, thus increasing the demand for electrical communications, may under other conditions have the opposite effect. If the key factor in a situation is the achievement of a fixed delivery deadline and the processing time is reduced, then the processing time saved becomes

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Paper 59-1093, recommended by the AIEE Data Communication Committee and approved by the AIEE Technical Operations Department for presentation at the AIEE Fall General Meeting, Chicago, Ill., October 11-16, 1959. Manuscript submitted May 11, 1959; made available for printing June 26, 1959.

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(communications + Electronics (v1) #50

available for communications. For example, if a 15-day deadline exists and 14 of those days are required for manual processing of data, then only one day is available for transmittal of the information, and electrical transmission may be necessary to meet the deadline. However, if an automatic data processor can prepare the information in 2 days, the remaining 13 days allow ample time for transmittal of the information in more routine fashion by mail or messenger, thus reducing the demand for electrical communications.

Whether the factors tending to increase communications requirements or those tending to decrease them are dominant in a particular case when automatic data-processing is introduced is, of course, not so much a function of the data-processing equipment as it is of the situation, and the concepts and techniques of employment of the equipment.

Which of these factors become dominant in a particular case when data-processing equipment is introduced is not so much a function of the equipment used as it is of the concepts and techniques of employment used. The equipment will have an impact upon communications requirements, but it is only a tool, and the user and his method of employment of this new and powerful tool will, in the final analysis, determine what its impact will be.

Data Terminals

Many practical cases of the close interrelation of transmission and processing functions are immediately obvious in the area of devices used for data entry and output. For example, computers frequently use paper tape readers similar to those used in teletypewriter transmitter distributors, and paper tape punches that could easily be used in teletypewriter reperforators. Similarly, the idea that various kinds of input-output devices such as card readers and punches and magnetic tape transports, widely used for data processing, can effectively be adapted for the use of communications lines is also being exploited in equipments such as the IBM (International Business Machines Corporation) Transceiver, the Collins Kinetape, etc.

FIELDATA emphasizes this kind of exploitation to the extreme, particularly encouraging it by assuring that interconnection of semiautonomous equipment modules be made in accordance with common standards, regardless of whether these equipments are conceived primarily for computer-associated or transmission-associated functions. This makes it possible for the same data terminals to operate with not only the data-processing type of inputs and outputs (such as computers, paper tape, magnetic tape, and IBM cards) but also with real time weapons system data, and with telegraphic data.

Control circuitry is so devised that pure binary as well as alphanumeric (alphabetic-numeric) data may be handled. Since any digital code, be it Baudot (teletypewriter), Holerith (IBM card), or any of a wide variety of computer codes, may be represented in binary bit-by-bit form, the FIELDATA devices have the potential of transmitting or handling any type of digital data. Thus they could be used with digitized voice, digitized facsimile, or other types of digitized analog signals.

The use of common standards, codes, and standard data rates makes possible the kind of data transmission equipment concept which leads naturally to a division of the subassemblies of data transmission equipment into three kinds:

1. *Input-Output Transducers.* These are devices for converting information from some human- or machine-usable form such as paper tape, magnetic tape, punched cards, analog electrical voltages, strokes on a keyboard, etc., into digital form.

2. *Transmission Transducers.* These are devices for converting data in digital form into appropriate signals for transmission over radio, wire, or other kinds of propagation media.

3. *Embolic* Equipment.* This is equipment which is normally inserted between input-output transducers and transmission transducers; it is used primarily to perform control and supervisory functions, error detection and/or correction, buffering and/or speed conversion, code conversion, or encryption necessary for proper system operation of the data transmission equipment. The functions of embolic equipment are information-processing functions. Inputs and outputs will both be digital in form although supplementary analog information may also be available particularly in some kinds of error control schemes. A general purpose computer is potentially a very powerful and flexible type of embolic equipment, but the necessary functions can often be performed much more economically by specialized equipment.

This division of subassemblies may be a physical division into separate items of equipment, or into semiautonomous parts of a single equipment (either in separate boxes or in a single box), or it may be merely conceptual with no physical implementation.

Obviously, maximum flexibility and adaptability can be achieved if any input-output transducer can operate with any transmission transducer. This permits one to tailor an equipment to meet the requirements of a particular situation. It permits one to choose the in-out device suitable for the user's most convenient data form (paper tape, magnetic tape, IBM cards, etc.) independently of the nature of the transmission facility available. One can then choose the transmission transducer on the basis of the transmission medium used (very-high-frequency radio relay, high-frequency radio, loaded cable, carrier transmission on wire, etc.) independently of the user's data form. Then the two are joined together to advantage of common standards of interconnection or intercommunication between modules and to create a well-tailored combination.

The question then arises, "Why embolic equipment?" Certainly, by proper choice of common interconnection or intercommunications characteristics, one can minimize requirements for code conversion, buffering, speed conversion, etc. Ideally, one should be able to join the input-output transducer to the transmission transducer without embolic equipment, so why have it? The answer is that there are three important functions in a data terminal which seem convenient to separate from both in-out transducers and transmission transducers: communications supervision, error control, and cryptographic security.

Supervisory functions are conveniently separated from the input-output transducers and the transmission transducers because supervisory requirements may be strongly influenced by both. Error control requirements may also be strongly influenced by both the in-out data and the transmission situation, and may even in some cases not be desired at all. Thus, it is best treated as a module which can be tailored to the paired requirements of in-out and transmission or completely omitted. Cryptographic security is conveniently a separate module so that it may be omitted in those cases where security is not required or desired.

Primary and Secondary Information

To discuss supervisory activities conveniently it is desirable to make a disin separate items of .to s iautonomous parts pmen (either in separate ingle box), or it may be ual th no physical im-

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* A coined term from the Greek *embolisimos*, to put between or insert. The word is also used in medical, astronomic, and ecclesiastic literature to describe other specific kinds of intercalations.

maxi..um flexibility and be achieved if any input- er n operate with any ans er. This permits eq ..pment to meet the f a particular situation. o ch se the in-out device us s most convenient er e, magnetic tape, .) independently of the ransmission facility avail- th choose the trans- cer n the basis of the edium used (very-high- o relay, high-frequency able arrier transmission dep dently of the user's en the two are joined to- tage of common standards on ntercommunication es a l to create a well- ation.

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Secc dary Information

pe sory activities con- desirable to make a dis-

tinction between two kinds of information which flow through a communications system primary and secondary information.

Primary information is that information which a user wishes transferred to another location, i.e., the information to be communicated.

Secondary information is that information added to the primary information either by the originator or by equipment of the communications system which is used to perform functions of supervision, routing, error control, and related activities necessary or desirable to permit the primary data to be effectively communicated. This information is used by communications equipment and personnel and is normally of no use or interest to the ultimate recipient of the primary information.

A basic requirement for maximum flexibility and adaptability is that the user, who enters data at an input device and receives data at an output device, need not be required to exercise judgment or knowledge, to perform special activities, or to use or interpret secondary information. This, in turn, makes it desirable to isolate secondary information from the input-output devices, which are the users' point of contact with the communications system. A convenient way of establishing and enforcing this isolation is the creation of a distinct embolic module which generates, receives, interprets, and/or acts upon secondary information and passes on action requirements derived from this secondary information over local control lines to its associated input-output transducer and transmission transducer. It is important to note that such an equipment need not have any ability to interpret or act upon primary data, and thus its operation can be made completely independent of the coding used for primary data so long as there is a unique method of distinguishing primary from secondary data.

In the FIELDATA family of equipments the segregation of primary and secondary data is accomplished in a particularly simple way by providing separate transmission symbol "alphabets" for primary and secondary data. The basic unit of data in FIELDATA codes is a 6-bit character. For primary data this may be merely a 6-bit block with no specific meaning assigned to specific bits within it, and no restrictions on the permissible code combinations which may be transmitted. If this information is alphanumeric in form so that specific bit meanings must be assigned for electric typewriters, printers, and similar input-output transducers to operate, then the FIELDATA alphanumeric code given in Appendix I is used. A similar but distinctly different 6-bit FIELDATA supervisory data code has also been created; see Appendix II. In situations where both FIELDATA primary data and FIELDATA supervisory code data might appear on the same six lines, the same six channels of tape, etc., a seventh bit is added to provide unique distinction. This seventh bit is normally a binary ONE for primary data and a binary ZERO for supervisory data. If, on a particular recording medium such as paper tape or on a particular kind of transmission channel, adequate reasons exist for tagging the difference between these two symbol alphabets in some other way, then other methods could be used. All secondary information except error control redundancy is handled by the FIELDATA supervisory data code in FIELDATA equipments.

The number, variability, and difficulty of measurement and analysis of the various factors which contribute to the frequency and interrelationships of transmission errors or particular circuits is staggering. At present, the state of the art is such that only crude estimates of frequency of error can be made for typical equipments when they are exposed to disturbances other than gaussian noise, and that practically nothing can be estimated in advance about the interrelationships of error under practical conditions of impulse noise, crosstalk, propagation variations, etc.

This is particularly unfortunate because the effectiveness of the various digital error control schemes available is strongly dependent upon the interrelationships of errors. For example, a simple parity check is capable of detecting single errors but not double errors. If errors occur randomly, double errors will seldom occur and this very simple check will be quite powerful. Thus, if the bit error rate is 10^{-4}, a simple parity check will reduce the undetected error rate to 10^{-8}. On the other hand, if errors tend to be clustered, a parity check will be rather ineffective. Thus, if the conditional probability of a second error immediately following the first is 0.5 and the bit error rate is 10^{-4}, then a parity check will reduce the undetected error rate to only 0.5×10^{-4}. Given knowledge of the interrelations, checks can be designed which give high protection with a minimum amount of checking equipment. Unfortunately this knowledge is usually unavailable.

If the most important sources of errors occur in a data communications link, is it proper to incorporate the major error control features of the link into the transmission transducers? The FIELDATA concepts answer this question with a very definite "No." The key reason for this is that while the *occurrence* of errors and the raw error rate and characteristics are determined primarily by transmission factors, the error *requirements* are determined by the use of the data. The means and techniques of error control appropriate to a particular situation obviously depend upon the interaction of these factors. However, it is a fundamental modularity principle of FIELDATA that the characteristics of transmission transducers should as nearly as possible be independent of the details of user input-output characteristics and data employment.

If one were to incorporate the error control features into the transmission transducers and one desired to provide p classes of controlled error service to users with q modulator-demodulator assemblies, then one would require p times q types of complete transmission transducers. The obvious answer is to separate modularly, making the error control module an item of embolic equipment. This allows one advantage of similarities in requirements and raw error characteristics among the different situations to reduce the variety of equipments to be constructed.

In view of the present difficulties in predetermining the specific error characteristics of transmission transducers prior to construction and test, it also permits construction of new transmission transducers and their use with existing error control embolic equipments until the specific error characteristics of the transducer can be measured, and new error control embolic equipment designed if necessary to meet user requirements with the measured transmission error characteristics.

In addition to these practical advantages of placing error control responsibilities in embolic equipment modules rather than in transmission transducer modules, there are conceptual advantages associated with maintaining the simplest possible information flow patterns and a division of activities among the three basic kinds of assemblies.

In general, transmission transducers pay no attention to the information content of the digital information they convert to modulated transmission form, neither knowing nor caring whether the data is primary or secondary data, whether it is redundant or irredundant, or what code or codes it uses. In contrast to this, embolic equipments normally act as information-processing devices. Thus, in supervising a transmission link, embolic supervisory equipments act on sensory information received from transmission transducers and in-out transducers. They generate, process, and interpret secondary supervisory information to control the over-all operation of the communications link.

The error control problem is exactly parallel. Acting on information about user requirements (from the in-out transducer side) and on information and sensory information about transmission errors from the transmission transducer side, error control equipment is required to generate, process, and interpret error control information, using it to control (often via supervisory operations) the over-all operation of the communications link in such a way as to control its errors. Thus it is obvious that from the information processing viewpoint the performance of error control as an embolic function has a close parallel to other embolic functions and is distinctly different from the functions otherwise performed by transmission transducers.

Among the FIELDATA equipments being developed in implementation of these concepts are the following:

Transmission transducers

AN/TSQ-32; 600–1,200 bps (bits per second); Stelma Corporation.
AN/TSQ-33; 600–2,400 bps; Collins Radio Company.
AN/TSQ-35; 19,200 bps; Bendix Aviation Corporation. Bendix Pacific Division, Bendix Aviation Corporation.

General-purpose computers

MOBIDIC; Sylvania Electric Products, Inc.
BASICPAC-LOGIPAC; Philco Corporation.
INFORMER-DATA COORDINATOR; International Business Machines Corporation

In-out transducers:

Electric typewriter; Smith-Corona, Inc.
Paper tape reader; Smith-Corona, Inc.
Paper tape punch; Smith-Corona, Inc.
High-speed printer; Anderson-Nichols and Company.
Paper tape transport; Ampex Corporation.
Magnetic tape transport; Ampex Corporation.
Taeden; Aeronutronics, Division of Ford Motor Company

Special embolic equipment

CV-689; cryptosecurity adaptor; Collins Radio Company.
CV-690; control equipment; Collins Radio Company.
CV-691; data concentrator; Collins Radio Company.

The transmission transducers of the FIELDATA family are limited in number. However, the choice of the 75×2^x pattern of data rates permits widespread augmentation by minor modification of existing or developmental teletypewriter multiplexed transmission equipments. In addition, future expansion is simplified by the fact that future equipments will be able to utilize the same embolic and input-output equipments, and will thus be cheaper to develop than data transmission equipments which require development of embolic and/or input-output equipment as part of the same package. Expected future expansion will place greater emphasis on transducers for radio circuits.

The *AN/TSQ-32* is a transmission transducer capable of accepting data from a standard FIELDATA connection and of transmitting it serially as frequency shift modulation of a single subcarrier over a standard voice channel. Transmission rates are 1,200 bps or 1,500 wpm (words per minute) over good quality circuits, and 600 bps over poorer circuits.

The *AN/TSQ-33* is a transmission transducer capable of accepting data from a standard FIELDATA connection and of transmitting it as eight channels, as synchronous phase quadrature modulation of four subcarriers over a standard voice channel. Transmission rates are 2,400 bps (3,000 wpm) over good quality circuits, with 1,200 and 600 bps available for use over poorer circuits. This equipment is essentially a militarized, miniature compatible FIELDATA version of the Kineplex *TE-206*.

The *AN/TSQ-35* is a transmission transducer capable of accepting data from a standard FIELDATA connection and of transmitting it by amplitude modulation of eight subcarriers orthogonally spaced in frequency and time. The transmission base band is the 48-kc band between 12 and 60 kc used for military and commercial cable and carrier circuits. Representative circuits are the Army spiral-4 and associated *AN/TCC-7*,- 8, and -11 equipments; and commercial types *N* and *K* carrier equipments. In addition to point-to-point full duplex operation this equipment has special features for the multiple-station "common net" round-robin type of operation.

In addition to these transmission transducers specifically designed for FIELDATA a wide variety of existing military and commercial teletypewriter transmission equipments can be used for FIELDATA transmission with only minor modification. Examples of such equipment are the *AN/FGC-54* capable of transmission and diversity reception of FIELDATA information at 2,400 bps over long-haul 3-kc radio circuits using 32 channels, which operate at 75 bps. Another example is the *AN/FGC-29*, potentially capable of transmission and diversity reception FIELDATA information at 1,200 bps using 16 channels which operate at 75 bps. Yet another example is the *AN/TCC-30* potentially capable of transmitting 1,200 bps using 16 channels which operate at 75 bps.

The FIELDATA computers form the most complete and well-balanced portion of the FIELDATA family. They may act as either input-output transducers or as embolic equipments for data transmission purposes, having the ability to accept, process, and emit either primary or secondary data. All are designed for direct operation with data transmission equipment. In their employment the MOBIDIC, which was the first machine to have its characteristics "frozen," is the least capable machine with regard to data transmission having serious restrictions on its use of the supervisory code functions. The most flexible in its employment of data transmission will be the data co-ordinator, a newer equipment which will be capable of terminating a large number of data transmission circuits simultaneously, and which will have a number of special capabilities and console positions to facilitate its use as a facilities co-ordination processor for an integrated communications data-processing system.

All the FIELDATA computers are general purpose processors of modular design and great flexibility. All of these computers are designed for field use with operation and maintenance simple enough for field personnel. The largest, MOBIDIC mounts in a semitrailer van, while the others mount in shelters which can be carried on a truck.

The input-output transducers of the FIELDATA family serve double duty as computer input-output devices and as data transmission input-output devices. The group under current development constitutes a minimum group of general usage items, a number of which are in only partially militarized form. This minimum group will be augmented by future field teletypewriter equipments which will utilize FIELDATA code, and by advanced equipments now under study to provide specialized input-output capabilities. The items are mostly quite conventional, and detailed descriptions are omitted here.

The specialized embolic equipments in FIELDATA provide cryptographic security, interconnection of input-output and transmission transducers, and tie-in of FIELDATA circuits to existing teletypewriter circuits.

Three major items of special embolic equipment are being developed for FIELDATA. The *CV-689* is a special cryptosecurity adaptor which permits an existing type of security equipment to be inserted just before the transmission transducer in any FIELDATA data transmission assembly, thus providing cryptographic security.

The *CV-690* is a device which provides supervisory control, error control, and synchronizing buffer facilities for connecting paper tape or magnetic tape units to the *AN/TSQ-32* or *-33*. Although future plans call for similar special militarized embolic equipments for other kinds of input-output equipment such as card equipment, none is now under development. However, rather minor modifications of commercial Collins Kinecard equipment will permit nontactical employment of *AN/TSQ-33* equipment for card transmission, and at least some versions of the MOBIDIC will include card equipment which, through the computer, can reach transmission facilities.

Although FIELDATA concepts make provision for a wide variety of error control and supervisory control systems, only the particular system used in the *CV-690* will actually be used initially, except for computer-to-computer transmission, since other embolic devices using different error control or supervisory control schemes are now under development. When experiments do determine the actual frequency and interrelationship of errors for particular transmission transducers, it is expected that more effective schemes will be devised. However, the very simple 2-dimensional (interlaced) parity error detection scheme followed by the request-back or rerun type of error correction used in the *CV-690* is particularly easy to implement, and is expected to suffice for initial testing.

The *CV-691* data concentrator is a device designed to bridge the gap between existing large-scale 60- and 100-wpm teletypewriter facilities and FIELDATA equipment. Although all FIELDATA processors have normal provision for a paper tape reader which accepts teletypewriter tape, as well as one for FIELDATA tape, there exists a significant need, especially at locations where FIELDATA processors might not be available, to accept multiple channels of teletypewriter information and convert this into FIELDATA form to take advantage of FIELDATA transmission transducers and error control, permit recording on FIELDATA magnetic or paper tape, permit printing on FIELDATA high-speed printers, simplify entry into FIELDATA computers, etc. The *CV-691* accepts up to 25 (or 50) teletypewriter inputs, stores the information in a buffer core memory (made up of the same memory planes as used in MOBIDIC), assembles it into message blocks, converts it into FIELDATA form, applies the same error and supervisory control as the *CV-690*, and emits the data in FIELDATA form at rates up to 2,400 bps (3,000 wpm). The receive side performs the inverse functions.

As more and more of the voice and other analog communications systems convert to pulse code modulation and other digital forms, it is expected that additional types of FIELDATA embolic equipment will be required to perform the error control, supervisory functions, and buffering synchronization necessary to tie input-output transducers to their digital bit streams.

The FIELDATA family is an attempt to create an integrated family of data transmission equipments to meet Army needs. Though it lacks many of the features and equipments of an ideal family of data transmission equipments, it will make available in experimental quantities by the end of 1960 the first integrated family of equipments for experimental establishment of a truly integrated communications data-processing system. It is the first system in which both data-processing and communications equipment utilize the same input-output and storage devices, the same voltages, impedance levels codes, and other common interconnection characteristics; it is the first in which the equipments are so designed that in many cases the only way to determine whether a device is used for communications or data processing is to look at its specific application in the system.

Appendix I. Fieldata Alphanumeric Code

The following table represents the alphanumeric code for alphanumeric information in specific form.

	000	001	010	011	100	101	110	111
000	MSP	SET	RESET	LF	CR	SP	A	B
001	C	D	E	F	G	H	I	J
010	K	L	M	N	⊙	P	Q	R
011	S	T	U	V	W	X	Y	Z
100	)	–	+	<	=	>	–	$
101	*	(	"	:	?	!		⊖
110	0	1	2	3	4	5	6	7
111	8	9	'	;	/	.	SPEC	IDLE

MSP: Called "Master Space"; printed symbol ⪢

SET: Causes a change of machine state or switch position. When translating to or from teletypewriters, this is interpreted as "Figures Shift"; printed symbol <

RESET: Causes the opposite change of machine state or switch position. When translating to or from teletypewriters, this is interpreted as "Letters Shift"; printed symbol ⁒.

CR: Carriage return; printed symbol <

LF: Line feed; printed symbol ←.

SPEC: Called "Special." Used as an escapement or alphabet expander. SPEC followed by another symbol forms a symbol pair with a new meaning which can be arbitrarily defined in any particular system. For example, SPEC A might be defined as α, SPEC B as β, etc. Extent of influence is only one symbol. However, the combination SPEC SPEC may be used to indicate that the characters following are to be interpreted by reference to a table of symbol assignments; printed symbol □.

IDLE: No information content; a deletable character.

Appendix II. Fieldata Control and Supervisory Code

Another 6-bit FIELDATA supervisory data code is described below. Though similar to that of Appendix I it has distinct differences.

Most Significant Bits	Least Significant Bits 000	001	010	011	100	101	110	111
000	← Format effectors →						a	b
001	c	d	e	f	g	h	i	j
010	k	l	m	n	o	p	q	r
011	s	t	u	v	w	x	y	z
100 101 110 111	Various system supervisory and control symbols such as "start of block," "end of block," "end of file," "are you ready?," "I am ready," "please retransmit last block," etc.							

In FIELDATA standard form, items, in the alphanumeric code, or other user (primary) data, are designated with a control bit in the ONE condition. If the communicator desires to restrict himself to the bottom half of the control code, eschewing the alphabet made available in the top half, then the resultant code is self-clocking because an OR of the control bit and of the most significant bit of the code will always contain a ONE.

If in a particular system it is desired to provide 2-case alphabetic operation, i.e., *a* or *A*, *b* or *B*, etc., for the easy-read or business correspondence type of format, one may absorb the alphabetic portion of the control code into the user (primary) information code. This gives a user alphabet of 96 symbols and a control and supervisory alphabet of only 32. In such a case a 2-bit test is necessary to separate control functions: i.e., both the control bit and the most significant information bit must be tested. Treating the control bit as the least significant bit for sorting a binary sort will result in sorting in the order a, A, b, B, c, C, etc. By treating it as the most significant bit the two cases will be alphabetized separately, i.e., a, b, c, d, etc.; then A, B, C, D, etc.

Moon Reflection Studies with Bistatic Radar at 3,000 Mc

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MEASUREMENTS have been made of moon-reflected radar signals transmitted by the Royal Radar Establishment from Malvern, England, and received by the Electrical Engineering Research Laboratory of The University of Texas at Austin, Texas. These supplement monostatic radar measurements made by a number of organizations and a few bistatic measurements which have been noted in news articles and mentioned at technical symposia. Reports have been made of monostatic measurements in the very-high-frequency (vhf) band by Trexler and Evans and in the 3,000-mc (megacycle) region by Yaplee and Hughes.[1-4]

The measurements reported in this paper were made to demonstrate the feasibility of receiving moon-bounce signals approximately one fourth of the distance around the earth and to obtain information on the character of the signals received over this path. The signal study should shed light on the surface of the moon, distance to the moon, the Faraday rotation in the ionosphere, and the motion of the moon.

Theoretical Considerations

It is obvious that signal detection is made easier by an increase in transmitted power and in the gain of the transmitting and of the receiving antennas. For the higher frequencies, the gain for a given size antenna is increased but so also is the cost of construction.

Bandwidth

The signal-to-noise ratio may be increased by decreasing the bandwidth. This bandwidth must, however, be wide enough to accept any changes in frequency due to Doppler effects associated with the earth's rotation, the moon's libration, and changes in distance between the earth and the moon. The bandwidth must also be wide enough to avoid pulse distortion. For this latter reason, it is possible to make measurements with comparably low-power continuous wave operation, while higher peak power is needed for pulse operation.

Scattering Cross Section of the Moon

The only uncertain factor in the radar equation, as applied to the moon returns, is the back-scattering cross section of the moon. This reflection is dependent on the smoothness of the moon surface relative to the wavelength used. For wavelengths of several meters, the moon's surface has been described by Siegel as quasi-smooth, implying that large areas of the moon are relatively smooth for this wavelength.[5] It would be expected, however, that for centimeter wavelengths, the moon's surface would appear rougher and have more areas which would serve as effective reflecting regions.

In addition to the roughness, the reflections from the moon will be influenced by the nature of the surface. A thick layer of low density dust might serve to reflect only a small amount of energy from the surface with additional reflections taking place from a solid layer beneath the dust.

Polarization Effect

For a linearly polarized transmitting antenna, the polarization at another location may be determined for two earth stations in the Northern Hemisphere north of the sublunar geographical position (GP), the first location observing after lunar transit and the second location observing before transit, by the following equation:

$$
\begin{aligned}
p=\text{arc tan}&\left[\cot\frac{A}{2}\left(\frac{\cos\dfrac{L_x-L_m}{2}}{\sin\dfrac{L_x+L_m}{2}}\right)\right]-\\
\text{arc tan}&\left[\cot\frac{A}{2}\left(\frac{\sin\dfrac{L_x-L_m}{2}}{\cos\dfrac{L_x+L_m}{2}}\right)\right]+\\
\text{arc tan}&\left[\cot\frac{B}{2}\left(\frac{\cos\dfrac{L_y-L_m}{2}}{\sin\dfrac{L_y+L_m}{2}}\right)\right]-\\
\text{arc tan}&\left[\cot\frac{B}{2}\left(\frac{\sin\dfrac{L_y-L_m}{2}}{\cos\dfrac{L_y+L_m}{2}}\right)\right] \qquad (1)
\end{aligned}
$$

where

p = polarization
L_m = sublunar latitude
L_x = latitude of the first station
A = difference in longitude between the lunar ground position and the station
L_y = latitude of the second station
B = difference in longitude between the lunar ground position and the station

If the linearly polarized receiving antenna is rotated with respect to the polarization of the incoming wave, the signal strength will be reduced by the cosine of the angle between the polarization of the antenna and that of the incoming wave. Thus a change in signal level caused by polarization effects will be encountered during a measurement period as the sublunar latitude and longitude vary as a function of time.

Faraday Rotation

The polarization of the radio wave going through the ionosphere will be

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Paper 60-518, recommended by the AIEE Radio Communication Systems Committee and approved by the AIEE Technical Operations Department for presentation at the AIEE Southwest District Meeting, Houston, Tex., April 4–6, 1960. Manuscript submitted December 28, 1959; made available for printing February 10, 1960.

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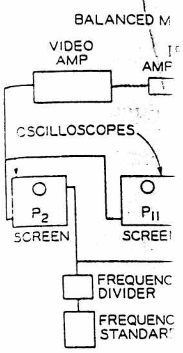
This work was possible only because of the excellent co-operation of the Radio Astronomy Group at the Royal Radar Establishment in England, who provided the essential transmission as well as many valuable suggestions concerning the reception technique.

The work conducted by the Electrical Engineering Research Laboratory of The University of Texas described in this paper was sponsored by the Wright Air Development Center under Air Force Contract *33(616)-6257*.



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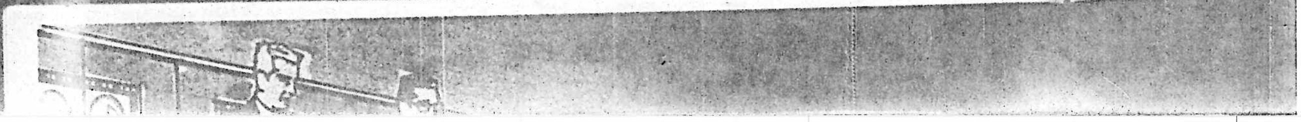

FRED W. SMITH, Assistant to Apparatus Engineer

European Teleprinter Developments

For years Western Union has been active in teleprinter development. Often with material aid from Western Union, the earlier designers in this country assiduously developed instruments suitable for American telegraph services. Now, widespread introduction into the Western Union system of printing telegraph apparatus made abroad has generated an increased interest in European designs.

WHEN the Committee on Technical Publication first requested an article comparing European and American teleprinters, there did not appear to be sufficient differences in the fundamental concepts of the two versions of printing telegraph apparatus to justify a full-length article on this subject. However, a study of various European teleprinters indicated that perhaps there were enough interesting variations to warrant a paper. The difference in geographical size of countries in Europe as compared with the United States, the different population densities, the many languages used, and the relatively short distances between industrial centers in most European countries resulted in a somewhat different approach to the solution of telecommunications problems in Europe.

Consultative Committee on International Telegraphy

In Europe the necessity for intercommunication between many countries each with its own language, concentrated in a comparatively small area, prompted early study of the possibility of establishing international standards for record communications equipment. While the telegraph industry was still in its infancy, the International Telecommunication Union (ITU) was established to promote adoption of standards acceptable to all member nations of the union. When the ITU was first established, telegraphy was the most widely used form of international telecommunications. When other forms of telecommunications, such as telephony and voice radio, became commonly used, the ITU organized separate committees to assume responsibility for various forms of telecommunications. The Consultative Committee on International Telegraphy (CCIT) was established to set up standards for the telegraph industry, and the Consultative Committee on International Telephony (CCIF) was organized to accomplish the same purpose in international telephony. Later these two committees were combined to form the Consultative Committee on International Telegraphy and Telephony (CCITT). The standards recommended by them and adopted by most of the countries of the world account for the major differences between European and American teleprinters.

The United States is not a signatory to these international agreements, however, and has not adopted the international standards for telegraphy. There are several reasons for this. At the time the standards were first proposed, Western Union had several thousand teleprinters in service and the United States was well in the lead in the use of printing telegraph apparatus. In deference to this fact, the CCITT abandoned the five-unit Baudot code assignment, then used in Europe for multiplex telegraphy, and adopted the Western Union Murray code character assignment for all letters of the alphabet. The marking and spacing pulse assignments for the letters of the alphabet in these two codes were different for almost every character.

Thus, the European members of the ITU made a major concession to the United States partly, perhaps, to encourage adoption by the USA of the ITU standards. However, the ITU did not

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adopt all of the upper-case character assignments then in use by Western Union. This resulted in several differences between the keyboards used in the United States and those adopted as the international standard. (Details of the differences as they exist today will be described later.) The United States participated in the ITU conference which adopted the new standard keyboard, but did not sign the agreement. The remote location of the United States and the relatively small volume of international telegraph communications between this country and Europe *at that time* probably did not seem to justify the expense involved in converting Western Union teleprinters to conform to the new standards.

Perhaps another reason for failure of the United States to adopt the CCITT standards was the fact that several independent companies provided telegraph communications service to the American public and each company operated independently of the others. By contrast, telegraph service in most of the countries in Europe was and is a government-owned monopoly and the problem of resolving conflicting interests did not exist within these countries.

The CCITT Keyboard

The standard page teleprinter keyboard[1] adopted by Western Union several years ago differs from the present standard CCITT No. 2 keyboard only in the upper-case character assignments of six letters. These differences are listed below:

LETTER	UPPER-CASE CHARACTER	
	W.U.	CCIT
D	$	Who are you?
F	¶	Not Used
G	&	Not Used
H	#	Not Used
V	;	=
Z	"	+

The CCITT standards prohibit use of the upper-case F, G, and H in international traffic. These three character positions are reserved for internal use and each member country is free to assign any desired character to the upper case of these three letters. Thus, there is no real conflict between Western Union's standard keyboard and the CCITT No. 2 keyboard on these three characters.

The CCITT agreement also prohibits the use of monetary symbols in international traffic, for rather obvious reasons. The many different currencies in use in various contries make it impractical to provide a monetary symbol for each currency on a keyboard limited to only 64 characters, including the essential nonprinting functional characters. Either by intent or by a fortunate coincidence, the CCITT chose to use the upper case D as the "who-are-you" character. Since Western Union uses the dollar sign on the upper case D and monetary symbols are prohibited in international traffic, this difference is of minor importance.

The two remaining differences between the two keyboards are possible sources of confusion and misunderstanding when direct customer-to-customer teleprinter communications between the United States and foreign countries becomes a substantial part of Western Union's business, as seems likely in the years to come. The plus sign used on the upper-case Z in international communications denotes the end of transmission. The plus sign followed by a question mark means "I have completed my message. Do you have anything to send?" The equals sign on the upper case V is used for its conventional purpose and has no other significance.

When Western Union established the first Telex exchange in New York[2] to permit direct customer-to-customer teleprinter connections with Canadian Telex subscribers,[3] a temporary solution was worked out to resolve the conflict between the Western Union keyboard used by our Telex subscribers and the CCITT No. 2 standard keyboard used in Canada. It was necessary to eliminate the dollar sign normally used on upper case D in order to use this code assignment as the who-are-you character. The key caps of the remaining five characters were modified to show the Canadian upper-case symbols in the upper right quadrant and the corresponding Western Union characters in the upper left quadrant. Thus, the upper right quadrants on the F, G and H key caps were left blank and the equals sign and plus sign, respectively, were embossed on the upper-case V and Z key caps. The standard Western Union symbols were printed on the upper left quadrants of these key caps. When an American subscriber communicates directly with a Canadian subscriber, he must not use the upper case F, G or H. If he uses the upper case V or Z, he must remember that these characters will not print a semicolon and quotation marks, respectively, on the Canadian teleprinter.

No discussion of the differences between the CCITT and United States keyboards would be complete without some mention of that used by the American Telephone and Telegraph Company. When the latter first decided to inaugurate a manual teleprinter exchange service (TWX) in the United States, it was apparently intended principally for brokerage use. The keyboard was equipped with fractions on many of the upper-case characters, presumably to expedite stock quotations. In addition, the bell signal was assigned to upper case S instead of J. This resulted in a keyboard that is radically different from both the standard Western Union and the CCITT keyboards, but is almost identical to the Western Union Type "C" keyboard used by many brokerage customers in leased-wire systems. The problems created in using it for direct customer-to-customer connections between foreign and TWX customers have discouraged the use of such connections and have probably had some effect on retarding the growth of international point-to-point connections to and from the United States.

The CCITT Code

The most significant difference between European and American teleprinters is in the speed of operation. The standard CCITT code has been described in the Technical Review previously,[4] but a brief review will be given for the benefit of readers who may not be familiar with it. This code uses a speed of operation of 400 characters per minute and a 7.5-unit code pattern. The start pulse and the five code pulses are each 20 milliseconds long and the rest pulse is 30 milliseconds long. The modulation rate is 50 bauds. (A baud is the inverse of the unit-pulse length in seconds.)

The code adopted by the CCITT is naturally attractive to engineers because of its numerical simplicity as compared to the roughly equivalent American codes with their 22-millisecond pulse lengths, 45.45-baud modulation rates, and 7.0- or 7.42-unit code patterns. There are, however, more tangible advantages in the CCITT code. The 400-opm speed simplifies the design of gears when a standard synchronous motor rotating at 1800 or 3600 rpm is used to drive transmitting apparatus, since no compromises in speed are necessary to obtain practical gear ratios. The 7.5-unit code pattern also simplifies the design of electronic distributors, use of which is rapidly increasing, as compared to the design for a 7.42-unit code pattern.

In Europe it is common practice to refer to the modulation rate in bauds, rather than to the speed in operations per minute or words per minute. This has the advantage of eliminating the necessity for specifying the code-pattern used, since all codes employing the same baud rate are compatible,[5] regardless of whether a 7.0-, 7.42-, or 7.5-unit code pattern is used.

To a telegraph engineer, the baud has additional significance. A square wave such as that generated by a teleprinter keyboard consists of a fundamental frequency plus an infinite number of odd harmonics. Theoretically, a perfect square wave cannot be produced without these harmonics. In actual practice, however, an essentially square wave can be generated by combining the fundamental frequency and the third and fifth harmonics. Thus, a circuit which will transmit all frequencies from the fundamental to the fifth harmonic without distortion will satisfactorily transmit the square wave. Since the baud rate is twice the fundamental frequency, a circuit which will satisfactorily pass frequencies up to 2.5 times the baud rate will transmit telegraph signals without appreciable distortion.

In some systems, when customer-to-customer teleprinter communication service is established between a customer in America and one in Europe, equipment must be provided to convert east-bound traffic from 45.45 bauds to 50 bauds and west-bound traffic from 50 to 45.45 bauds. In the case of TWX subscribers in the USA, equipment must also be provided to convert the upper-case characters used in TWX so that the character transmitted by a TWX subscriber will print the correct character or sequence of characters on the CCITT teleprinter. If the fraction $\frac{7}{8}$ (upper case N) is transmitted, it must be converted to print three characters: upper case U (7), upper case X (diagonal), and upper case I (8). Similarly, transmission from a European to a TWX teleprinter must also be converted. Under the CCITT regulations, the burden of furnishing the necessary conversion equipment must be borne by the company or country which does not use the CCITT standards, and since this equipment must be provided for every telegraph channel, the initial cost and the maintenance cost could be burdensome to American companies which provide Telex service to Europe. Also, the speed differences and keyboard variations prohibit *direct* interconnection of American and European subscribers. In the case of west-bound traffic, tape storage is necessary because of the higher transmission speed used in Europe.

Recently, Western Union adopted the CCITT standard 50-baud modulation rate for use on its Telex teleprinters and Telex ASR sets and also changed the upper case F character from the paragraph sign to the dollar sign. Western Union's Telex teleprinters were also modified to print 69 characters per line, which is the CCITT standard, instead of 72. After this conversion was completed, the only remaining discrepancies between the CCITT No. 2 standard keyboard and Western Union's Telex keyboard were in the upper case V and Z character assignments previously described.

A great deal of this article has been devoted to discussing the CCITT standards because their adoption in Europe but not in the USA has created the only fundamental differences between standard American and European teleprinters. There are, of course, other minor differences, but these two (code assignment and speed) are the only ones which prevent direct interconnection. The other differences to be described are primarily due to the varying requirements that exist in Europe and America and are mainly differences in accessories rather than in fundamental design.

Message Switching Versus Circuit Switching

In Europe, the geographical size and population densities made Telex-type circuit-switching systems practical. In the United States, on the other hand, greater distances between cities and lesser population density made message-switching systems more economical. Circuit-switching systems utilize trunk circuits between major switching centers much less efficiently than message-switching systems, and this is particularly true of automatic circuit-switching systems such as Telex.

The number of trunk circuits required between two circuit-switching centers is determined by the volume of traffic and the permissible number of lost calls during the busy hour due to lack of availability of an idle trunk circuit. During periods other than the busy hour the trunk facilities available are far greater than the minimum number required to handle satisfactorily the volume of traffic. In message-switching systems, on the other hand, delays of several minutes during the busy hour are not serious and there is no lost-call rate involved in these systems. In manual circuit-switching systems where an operator must establish each connection, as in TWX, a much higher lost-call rate can be tolerated, since the manual switchboard operator can call back the customer who initiated the lost call when an idle trunk circuit becomes available, thus making it unnecessary for the customer to initiate a call the second time.

In Europe, where distances between major cities in most countries are short as compared with the United States, inefficient use of trunk circuits was relatively unimportant. In the latter country, on the other hand, greater distances between many of the major cities and the resulting high cost of trunk circuits dictated the use of message-switching systems during early development of telegraph switching systems. However, rapidly increasing population density and the growth of industry, with an accompanying increase in telegraph traffic in the business community, and technical developments such as new carrier systems which have reduced the cost per mile of telegraph circuits, are reducing the economical advantages of message-switching over circuit-switching systems.

Automatic circuit-switching systems

provide faster communication between any two subscribers than is possible in a message-switching or a manual circuit-switching system. In today's Telex, for example, any subscriber can obtain a direct point-to-point connection with any other subscriber in the system within ten seconds by dialing a six or seven-digit number. Since modern Telex is an automatic unattended service, it is essential that the calling subscriber be able to identify the station to which he is connected, even though the called station is unattended. This requirement led to the development of automatic answer-back units, available as a standard accessory on all European teleprinters.

Automatic Answer-Back Unit

Answer-back units used on most European teleprinters consist essentially of a rotatable drum or cylinder equipped with coding discs or combs which control the keyboard contacts when the answer-back unit is actuated. A ratchet and pawl are generally used to step the drum through one complete revolution when the who-are-you character (upper case D) is received by the printing unit. Power for stepping the answer-back unit is supplied by the keyboard transmitting shaft, which steps the drum once for each revolution of the shaft. At the end of one revolution of the answer-back drum, the feed mechanism is automatically disengaged and the drum stops rotating.

During the revolution of the drum, the coding elements control the characters transmitted from the keyboard transmitter. The keyboard shaft driving clutch is allowed to remain in the engaged position so that the transmitting shaft rotates continuously until the answer-back drum completes its revolution, at which time the keyboard clutch is mechanically disengaged and the answer-back unit comes to rest in its home position.

One revolution of the drum transmits from 19 to 21 characters, depending on the design of the answer-back unit, and these characters can be coded to identify the subscriber, either by transmitting his name, an abbreviation of his name, or his Telex number. However, a word or code name is almost always used in preference to the Telex number, since this provides a cross-check for the calling subscriber and gives some protection against errors in reading the Telex number from the directory.

In order to prevent simultaneous transmission of answer-back codes from both teleprinters in a point-to-point connection, the answer-back unit must be prevented from responding to an upper-case D transmitted from its own keyboard. This is accomplished mechanically by blocking the answer-back triggering device momentarily when the D key lever is depressed. A separate off-line key called a "here-is" key is provided for locally tripping off the answer-back unit without sending the who-are-you character to the line.

Perforated Tape Accessories

Tape perforating and transmitting equipments used with European teleprinters are quite different from their American counterparts. Most of the teleprinters made in Europe can be equipped with an auxiliary tape reperforator which is mechanically linked to the printing unit, so that tape and page copy can be prepared simultaneously when a message is received or transmitted. Linking the reperforator to the printer in this manner eliminates the need for a second receiving selector assembly and simplifies the design of the punching unit. However, it also imposes certain limitations on the unit. For example, a tape cannot be perforated for subsequent transmission without also obtaining a page copy of the message, since the keyboard must transmit to the printing unit in order to operate the punching unit. With this method of operation, the keyboard must always be operated as a cadence keyboard and there is no provision for manually switching to a "free" keyboard position for tape preparation without a hard copy. A mechanical switch is provided, of course, so that the reperforator can be turned on or off.

The who-are-you character must not be perforated in tape which is to be transmitted over an automatic circuit-switching system, since it would actuate the automatic answer-back unit at the distant station and result in "busting up" at least 20 characters while transmission was occurring simultaneously in both directions. In order to prevent such accidental perforation, most European perforator attachments on teleprinters are arranged so that the D character cannot be perforated from the keyboard when the teleprinter is in the upper case.

A distributor-transmitter attachment is also available as an accessory on most European teleprinters. This unit is driven by the teleprinter motor through the necessary additional gear trains. These attachments are generally very simple in design, with few special features provided other than a tape-out pin.

Compared to their American equivalents, the tape perforating and transmitting attachments used on European teleprinters are very simple but are limited in versatility. Their simplicity, however, results in a considerable cost advantage over equivalent automatic send-receive sets manufactured in America. In general, the cost of a European teleprinter delivered in the USA, duty-paid, is comparable to the cost of an equivalent American-made teleprinter, but the cost of a European teleprinter equipped with tape perforating and transmitting attachments is on the order of 30 percent to 50 percent less than the cost of an American-made ASR set. The lack of versatility of the European ASR sets is not particularly important in Telex service, where the necessary automatic controls are incorporated in the switching system rather than in the terminating equipment.

Two-Color Printing

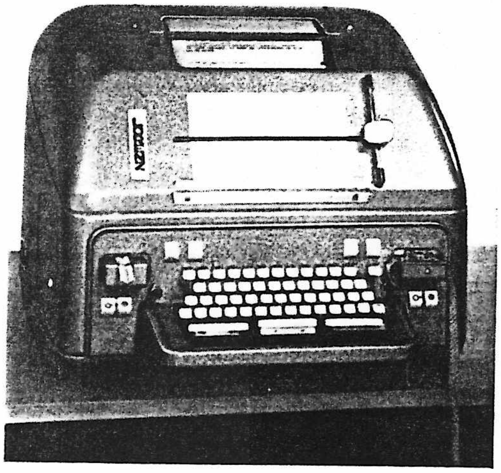
One feature used on many European teleprinters, but almost unknown in the USA, is two-color printing for distinguishing between sent and received messages. When a teleprinter is equipped with this attachment, messages received by the typing unit are printed in black, but when messages are transmitted from the keyboard a ribbon-lifter mechanism, usually associated with the keyboard, causes printing to occur in the red half of the ribbon. The device is fully automatic so that no conscious effort on the part of the operator is required to utilize the two-color printing. This attachment is useful in automatic circuit-switching systems where two-way conversations are frequent. It also helps to distinguish between sent and received messages which have been filed away for future reference.

The Four-Row Keyboard

In Europe, three different types of keyboards are available for most teleprinters. One is the conventional 3-row keyboard used in the USA. The second type is the so-called "4-row standard" or "4-row expanded" keyboard in which every upper-case printing character is placed on a separate key lever instead of being combined with its corresponding lower-case character. For example, the letter E and the digit 3 are on separate key levers. When the letters-shift key lever is depressed, a sliding bar equipped with blocking lugs is automatically positioned so that all upper-case key levers are blocked and cannot be depressed. Similarly, when the figures-shift key lever is depressed, all letters key levers are blocked. Thus. an operator cannot erroneously transmit letters characters when the keyboard is in the figures case, and vice versa.

There are two advantages to this type of keyboard. First, it more closely resembles a typewriter keyboard than does any other type of teleprinter keyboard. Secondly, it is impossible for a touch typist using this keyboard to transmit errored characters due to the keyboard being in the wrong shift case. These two advantages are important to users who send and receive a small volume of telegraph traffic and who therefore assign a typist or secretary to operate the teleprinter. For a professional teleprinter operator, however, the large number of keys (usually 57) on this type of keyboard seems awkward and inefficient.

The third type of keyboard available is a compromise between the 3-row and the 4-row standard which appeals to many typists and teleprinter operators. This keyboard, known as the "4-row condensed", separates the ten digits from their corresponding lower-case characters and these digits are placed on a fourth row of key levers just above the top row of letters keys. Punctuation marks and symbols are not placed on separate keys. The same type of letters-figures blocking bar used on the 4-row standard keyboard is also used on the 4-row condensed version. When the letters key is depressed, this bar blocks only the row of figures keys. When the figures key is depressed, the top row of letters keys (QWERTYUIOP) is blocked. This provides the same protection, but to a lesser degree, as the blocking bar on the 4-row standard keyboards. In the English language, the top row of letters characters contains several letters that are among the most frequently used and it is difficult to type more than a few letters in normal English without using one of these characters.



Courtesy Intelex Systems, Inc.

Figure 1. Lorenz LO-15B Teleprinter with tape reperforating and transmitting attachments

A question frequently asked by those who are not familiar with the 4-row European keyboards is whether the upper-case characters are compatible with the upper-case characters on American keyboards; that is, if the digit 3, for example, is transmitted from a 4-row keyboard, will the American teleprinter print the 3? The answer, of course, is that the two are compatible except for the differences previously cited between the CCITT No. 2 and the American keyboards. Separation of the upper-case characters on the keyboard is purely mechanical and has nothing to do with the code combinations assigned to these characters.

Major European Teleprinter Manufacturers

The four major manufacturers of teleprinters in Europe are Lorenz and Siemens & Halske in Germany, Olivetti in Italy, and Creed in England. All four of these companies are major manufacturers of telegraph apparatus and all of them export their products to countries all over the world. Lorenz and the Creed company are both affiliates of the International Telephone and Telegraph Corporation.

Lorenz LO-15 Teleprinter

The Lorenz Model LO-15B Teleprinter, shown in Figure 1, was originally manufactured under license from Teletype Corporation, and the close resemblance between the Lorenz LO-15 and the Teletype Model 15 is readily apparent when the cover is removed, as in Figure 2. Minor design changes were made in the basic teleprinter by Lorenz engineers, particularly in the keyboard. The transmitting shaft clutch trip mechanism was redesigned and the universal bar mechanism was modified to reduce the force required to position the universal bar. These two relatively minor changes produced an appreciable improvement in the keyboard touch and reduced the possibility of repeat-character errors (two successive transmissions of the same character when a key lever is depressed only once). However, the principal contribution made by Lorenz engineers was in the design of the answer-back unit, the reperforator attachment, the distributor-transmitter attachment and the 4-row keyboard shown in Figure 1. In this illustration, the perforator attachment is located at the left of the keyboard and the perforated tape can be seen feeding out towards the front of the teleprinter. The two push buttons just below the perforator are the "on" and "off" buttons. The button on the left is the off button and is indicated by a circle with a dot outside the circle. When this button is depressed the perforator is turned off, or *out* of operation. The button on the right, with a dot inside the circle, turns the unit on, or puts it *in* operation. The distributor-transmitter attachment can be seen at the right of the keyboard with tape feeding from right to left. The on and off buttons for this attachment are located directly below the reading head.

The answer-back unit, mounted behind the cover on the right side of the keyboard base, can be seen in Figure 2. The here-is key is located just to the left of the answer-back unit. Depressing this key mechanically releases the answer-back unit and causes it to transmit the answer-back code once.

The Lorenz teleprinter illustrated in Figure 1 is a late model incorporating a number of design changes. In former models, such as the one shown in Figure 2, the tape fed through the transmitter from front to back. After passing over the reading head, it made a complete loop behind and beneath the transmitter and emerged from the front of the unit. The cover of the LO-15B has also been redesigned and presents a much more modern appearance than the older covers, which were very similar to the Teletype Model 15 Teleprinter covers.

Metric threads are used on all fasteners on the Lorenz teleprinter, as they are on most European teleprinters. The gears are also manufactured to metric standards. In spite of this, more than half of the parts used on Lorenz teleprinters are interchangeable with corresponding parts used on Teletype Model 15 Teleprinters. Western Union, in fact, has adopted the Lorenz answer-back attachment for use on Model 15 Teleprinters manufactured by Teletype for use in Western Union Telex service. It is necessary to furnish only a few minor parts manufactured by Western Union in order to permit installation of the Lorenz answer-back on Western Union's teleprinters.

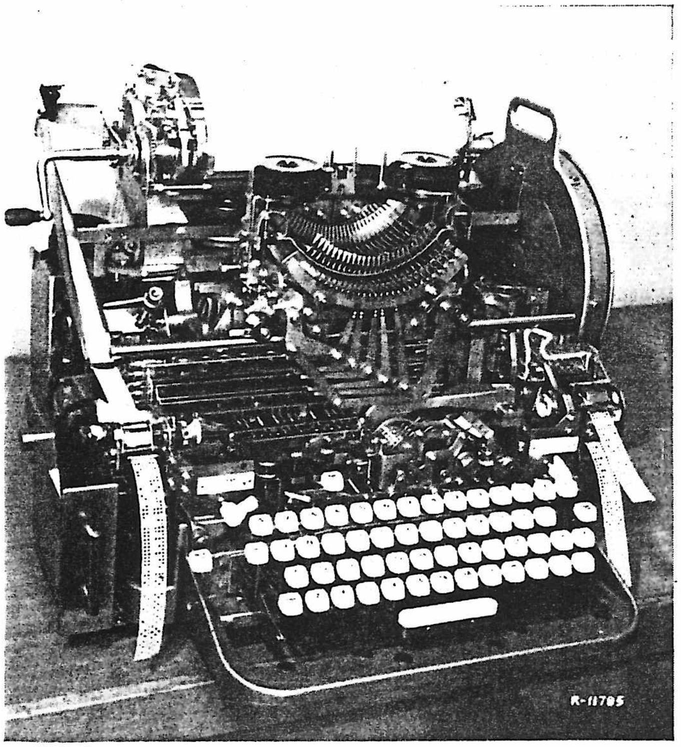


Photo R-11,785

Figure 2. Lorenz Model LO-15A Teleprinter Set with cover removed. Teleprinter shown is equipped with a 4-row standard keyboard

Olivetti Teleprinter

The Olivetti teleprinter shown in Figure 3 is equipped with a 3-row keyboard, an answer-back unit with a 21-character capacity, a tape perforator attachment, and two-color printing. The type basket on this teleprinter is stationary and the platen assembly moves from right to left as a line is printed, as on Western Union's Type 100 Teleprinters. All keys except the carriage return key are automatically locked when the platen reaches the end of a line, thus preventing overprinting. Depressing the carriage return key unlocks the keyboard. The teleprinter is made up of seven subassemblies which can be removed readily as complete units. The receiving selector assembly, which has excellent tolerance to distorted signals, can be used to receive either make-break or polar signals. Conversion from one mode of operation to the other can be done quickly and easily. Likewise, the sending unit can transmit either make-break or polar signals.

Unlike most European teleprinters, the Olivetti does not use a friction-type receiving selector clutch. The clutch used is an all-metal one with three pawls, any one of which can engage internal teeth on a clutch drum surrounding the pawl assembly. There are 58 teeth on the drum and the three pawls are spaced 120 degrees apart. Since 58 is not divisible by three, only one pawl can engage the toothed drum at one time and there are 58 times 3, or 174 possible engagement positions. The variation in take-up time of the clutch is thus equivalent to only a little more than two degrees rotation of the selector shaft.

Mounted just to the left of the receiver range scale is a vibrating reed type of speedometer, used to indicate the speed of the governed motor. This speedometer is claimed to be accurate within 0.2 percent and is quite convenient for use in adjusting the motor speed. Governed motors, incidentally, are far more commonly used on European teleprinters than a-c synchronous motors because of the many different voltages and frequencies used in European power systems and also because of the relatively unstable frequencies in European a-c systems.

The maximum speed of the Olivetti teleprinter is 75 words per minute. The trend towards higher speeds is not as prevalent in Europe as it is in this country and until very recently European teleprinters were not designed for 100-word-per-minute operation.

The perforator attachment and its tape supply reel are located on the left side of the teleprinter. This unit punches chad tape with in-line feed holes, as do all European perforator attachments. The receiving selector, located just below the range scale which is clearly visible at the left center section of the photograph, controls the punch positioning mechanism which determines the characters to be perforated in the tape. The answer-back unit, which cannot be seen in the photograph, is located beneath the transmitting contact assembly. The latter assembly, which is to the right of the right ribbon spool shaft, is enclosed by a transparent plastic cover which protects the contacts from oil and dirt while permitting the operation of the contact mechanism to be observed.

The Olivetti model shown is equipped with a special 3-row keyboard roughly corresponding to the TWX keyboard. When the figures-shift key is depressed, the D key lever is automatically blocked so that the who-are-you character cannot be transmitted accidentally. A separate who-are-you key lever is provided for transmitting the D character when the keyboard is in the upper case. This key lever is one of the group of three separated from the three rows of standard key levers and located at the upper right of the keyboard. With the keyboard in the figures position, depressing this key lever will cause the transmitting contacts to send the D character. A second key lever in the group of three is the here-is key, which mechanically trips the answer-back unit to transmit the teleprinter's own identifying code. The third key in this group is a repeat-character key, known in European terminology as a run-out key. Holding this key lever down causes the last character transmitted to be sent continuously.

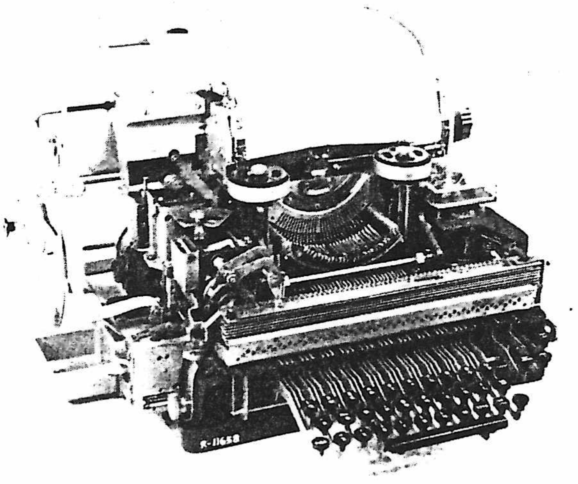


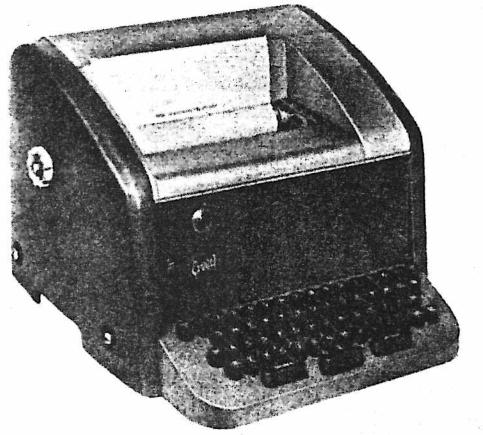
Photo R-11,658

Figure 3. Olivetti teleprinter and reperforator attachment with cover removed

A tape transmitter attachment is not available for the Olivetti teleprinter and a separate distributor-transmitter must be used for tape transmission.

Creed Model 75 Teleprinter

In 1958, Creed and Company in England started production of a new page teleprinter designed to replace older Creed models. This teleprinter, known as Creed Model 75, is the only teleprinter described here which has not been tested or evaluated by Western Union. However, it has been demonstrated to Western Union engineers and a description of the unit has been published.[6] The Model 75, shown in Figure 4, is a very compact unit, measuring 15-3/4 inches in over-all width, 15-3/16 inches in depth, and 11 inches in height. A send-receive teleprinter weighs approximately 42 pounds.



Courtesy Intelex Systems, Inc.

Figure 4. Creed Model 75 Teleprinter

Unlike previous Creed teleprinters, the "75" has a stationary platen and a moving typewheel, instead of the moving platen and fixed typewheel used in previous Creed models. The typewheel has four rows of characters, with 16 characters in each row. The top row and the 3rd row contain the letters characters and the 2nd and 4th rows contain the figures characters. A link-type aggregate motion mechanism combined with rack and pinion mechanisms are used to position the typewheel to the selected vertical and rotary positions. The 2nd pulse, in combination with the letters-figures mechanism, determines which vertical row of type will be raised to the printing level. When the typing unit is in the letters-shift position, a 2nd pulse marking will select the 1st row of type and a 2nd pulse spacing will select the 3rd row. With the typing unit in the figures-shift position, a 2nd pulse marking will select the 2nd row of type and a 2nd pulse spacing will select the 4th row. The 3rd pulse determines whether the typewheel will be rotated clockwise (3rd pulse marking) so that a character in the left half of the typewheel will be selected, or counterclockwise (3rd pulse spacing) so that a character in the right half will be selected. Pulses 1, 4 and 5 determine the angle through which the typewheel will be rotated and, thus, which of the eight characters in the selected half of the row will be brought to the printing position. A type hammer is not used for printing. The typewheel itself strikes the ink ribbon and platen to perform the printing.

Perhaps the most novel and interesting feature of the Creed 75 is the translator unit. This unit positions the typewheel when signals are received by the selector magnet on the receiver. It also transmits signals to the line and positions the typewheel when the keyboard is operated. The keyboard is mechanically linked to the typing unit. When a key lever is depressed, the code corresponding to this key lever is set up on five combination bars. These bars set up the code mechanically on a set of five selecting pins on the translator unit. A group of six cams on the translator then positions the typewheel mechanically to correspond to the character transmitted. A second group of nine cams on the translator operates the transmitting contacts to send the selected character to the line and to reset the keyboard so that a key lever can again be depressed. The keyboard is reset about one-third of the way through the transmitting cycle. Operation of the keyboard thus mechanically positions the typewheel and initiates the printing cycle, independently of the line transmission from the transmitting contacts on the translator unit. This reduces the delay between the depression of a key lever and the subsequent printing of the selected character, resulting in a touch similar to the touch on a typewriter, rather than on a conventional teleprinter. With this arrangement the keyboard is not a true cadence keyboard and the speed of typing can vary somewhat above and below the speed for which the teleprinter is geared. The Creed 75 is capable of operating at speeds up to 100 words per minute.

When signals are received by the selector magnet, the five selecting pins on the translator are positioned by the selector armature instead of the key levers on the keyboard. The cams on the translator position the typewheel in the same manner as when the keyboard is operated.

A send-receive switch operated by a cam on the translator shorts out the transmitting contacts when signals are received by the selector so that the transmitting contacts will not repeat the received signals. Similarly, the selector magnet is disconnected from the receiver when the keyboard is operated.

A tape reperforating attachment is already available for the Creed 75 and a tape transmitting attachment is expected to be available soon. The reperforator attachment mounts on the right-hand side of the teleprinter instead of the left-hand side, as on the Lorenz, Olivetti, and Siemens & Halske teleprinters.

Siemens & Halske T Type 100 Teleprinter

The "T Type 100" teleprinter manufactured by Siemens & Halske in Germany is of particular interest to Western Union, since this teleprinter with its tape reperforating and transmitting attachments has been adopted for use by Western Union as a Telex ASR set after extensive laboratory and field tests. This ASR set, with a Telex remote control unit (dial box), is shown in Figure 5. The reperforator attachment, tape supply reel, and chad box are mounted on the left side of the teleprinter. There are four push buttons on this attachment. The top left button (labelled with a dot outside the circle) turns the reperforator off and the bottom left button turns it on. The top right push button (labelled "L") lifts the feed pressure roller to permit tape to be threaded into the reperforator. The lower right button (marked "R") is the backspace control. Depressing and releasing this push button once causes the reperforator to backspace one character. Just below the four control buttons is a pointed tearing edge for the perforated tape. When this edge is used for its intended purpose, a message tape from the reperforator will be torn in the shape of an arrow with the head of the arrow at the beginning of the tape and pointing in the direction in which the tape should feed through the tape transmitter. This feature is very useful since the reperforator punches nonprinted chad tape with in-line feed holes.

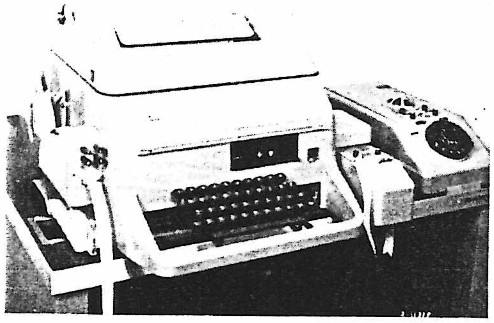


Photo R-11,320

Figure 5. Siemens & Halske Model 100 Teleprinter with tape reperforating and transmitting attachments. The "dial box" at right is a Telex remote control unit

The most interesting feature of the reperforator is that friction feed is used for feeding the tape. The tape passes between a feed roller and a spring loaded pressure roller which holds it firmly against the feed roller. There are no pins to engage the feed holes in the tape. This method of feeding has proven to be very satisfactory and maintaining the 10-characters-per-inch gauge of the tape has presented no difficulty.

The teleprinter shown in Figure 5 is equipped with a 4-row condensed keyboard, but both 3-row and 4-row standard keyboards are available and any one of the three types can be converted to any other. Just above the top row of keys are six off-line control levers mounted in the cover. The first lever on the left is the repeat-character (run-out) lever and is identified by a series of dots to indicate repetition. The third lever from the left is the here-is control which mechanically trips off the answer-back unit to transmit the teleprinter's identifying code.

It is identified by the here-is symbol imprinted on it. The fourth lever from the left is a latching type switch lever which turns on the copy light. It is identified by an electric lamp symbol imprinted on it. This is the only one of the three levers described which latches in the operated position. It is unlatched by pushing down on the projection at the bottom of the lever. The three remaining controls are not used at present, but are provided for use with accessories now under development, such as local carriage return, line feed, or letters shift. The copy light shield shown in Figure 5 can be tilted to any desired position to prevent reflections of external lights in the transparent copy window. It can be removed readily by the operator if it is not needed.

The tape transmitting attachment fastened to the right side of the teleprinter is equipped with two push buttons which mechanically turn the transmitter on or off. A tape-out pin mechanically operates the off push button after the end of the tape passes over the pin. A remote control magnet built into the transmitter attachment provides a means for stopping the transmitter from the distant end. This magnet is connected in series with the line. If the line is opened while the transmitter is sending a rest pulse, the magnet armature will release and trip the mechanical off push button. The receiving station can thus stop the transmitter by sending one or two blank characters or by momentarily opening the line. The transmitter will transmit from either chad or chadless tape with in-line feed holes.

The Siemens & Halske Telex ASR set is shown in Figure 6 with the cover removed. The vertical die casting at the left side of the keyboard, just to the right of the reperforator attachment, contains the keyboard transmitting contact assembly. This is a single-contact type of transmitter and the contact is operated by an insulated cam mounted on a rocker shaft. The contact assembly can be either a make-break form for transmitting single current signals or a transfer form for transmitting polar signals. The contacts are completely enclosed in a metal housing to reduce radio interference and to protect the contacts from dust and dirt.

The answer-back unit is located just to the right of the transmitting contact assembly. When the answer-back unit is tripped off, it controls the transmission of 20 characters from the keyboard transmitting contact assembly. The first and the last characters transmitted must be the letters combinations, but the remaining 18 characters can be coded for any desired combinations. The coding drum is equipped with 18 replaceable code combs which are inserted in slots around the periphery of the drum. Each comb has five tines on it, one for each of the five code pulses. A comb is coded for any desired character by breaking off tines corresponding to marking pulses. The coding drum can be removed from the answer-back unit quickly and easily by depressing a latch and sliding the drum off its shaft. This permits the coded answer-back drum to be swapped from one teleprinter to another in a few seconds.

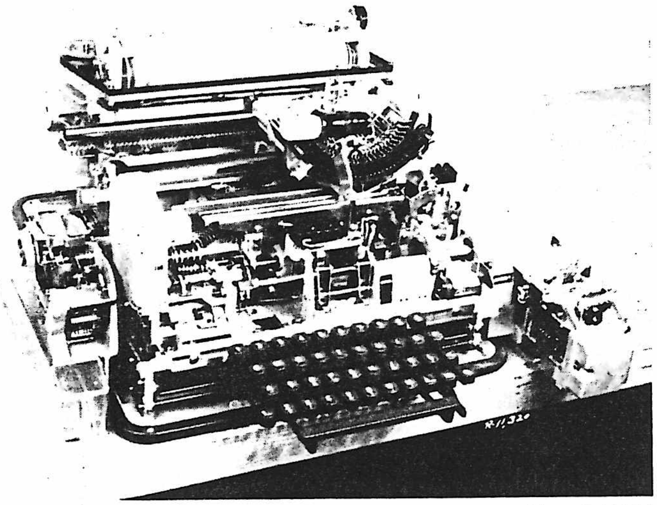


Photo R-11,319

Figure 6. Siemens Model 100 Teleprinter Set (Telex ASR Set) with cover removed. Teleprinter shown is equipped with a 4-row condensed keyboard

At the extreme right side of the keyboard base is an hour counter which registers the total time in hours that the teleprinter motor has been running. This feature is very helpful in determining when routine maintenance should be done on the teleprinter, and most European teleprinters are equipped with hour counters.

The platen step mechanism can be set for a line spacing of 4.3, 6.4, or 8.5 millimeters. This is roughly equivalent to 6,4 and 3 lines per inch, respectively. The teleprinter shown in Figure 6 is equipped with a bichrome ribbon and a two-color printing mechanism. Normally, only messages transmitted from the keyboard will be printed in red, but an accessory set of parts is available which automatically controls the two-color shift mechanism when tape is transmitted by the tape transmitter attachment, so that all messages sent from the teleprinter will print in red.

The Siemens & Halske teleprinters used by Western Union are driven by either a 3600-rpm a-c synchronous motor or a 3750-rpm governed motor. The motors are fully enclosed for radio-frequency suppression. The teleprinter will operate at any standard speed up to and including 100 words per minute. Since the transmitting cam sleeve is designed for a 7.5-unit code pattern, the actual transmitting speed at 100 wpm is approximately 594 operations per minute. In order to achieve satisfactory operation at 100 wpm, the moving type basket used on the Model 100 Teleprinter had to be carefully designed for the lightest possible weight consistent with rugged construction. The type basket carriage assembly weighs approximately 2 pounds. It is fed from left to right by a lead screw which ensures smooth feeding movement. The standard type pallets print lowercase letters characters, but pallets are available for printing capital letters when required. The spacing between characters is 2.6 millimeters instead of the 2.54 mm (10 per inch) spacing used on American teleprinters.

One of the most interesting features of the new Siemens teleprinter is the receiving selector unit. The selector magnet on this assembly is equipped with two armatures, one for stopping and starting the receiving selector shaft and the other for sampling the five code pulses. Both armatures are of the holding type; that is, each armature is mechanically moved to the marking position by an associated cam. If the magnet is energized at this time, the armature will be held in the marking position magnetically. If the magnet is not energized, the armature will be returned to its spacing position by an extension spring. Greater motion and more force are required to start and stop the receiving shaft than to sample the position of the selector armature in a teleprinter. Providing twin armatures to separate these two functions permits less movement and force to be used for the selector armature and results in greater accuracy in the selecting function. This design has resulted in an unusually good receiving margin. The Model 100 Teleprinter has a tolerance to signals containing 44-percent marking or spacing distortion. The holding-type armatures also permit the teleprinter to operate on line currents of from 40 to 60 milliamperes with no appreciable loss in receiving margin. (The standard line current for make-break signalling in Germany is 40 ma and the standard line battery is 60 volts.)

The receiving selector is driven by an enclosed felt-type friction clutch. The design of this clutch permits satisfactory operation for 1000 hours without reoiling. Lubrication intervals of 1000 hours have previously been obtained only by use of all-metal clutches. At the same time, the clutch retains the advantage of constant pickup time inherent in friction clutches. This also contributes to the wide tolerance to signal distortion of the receiver.

* * * * *

In Europe, there are relatively few large private wire switching systems such as those designed by Western Union for use by private industry and government agencies. There this type of traffic is usually switched over one or more of the very extensive Telex systems. Public message traffic in many countries is also handled over Telex systems built for this purpose and called Gentex (General Telex). Two-party lines can be used in Telex systems, but use of more than two stations on one line is almost unknown in Europe and the need for elaborate "stunt boxes" on teleprinters, with their associated way-station selectors, does not exist. Also, Telex systems are normally operated half-duplex and there is little demand for elaborate ASR sets which will permit simultaneous sending, receiving and off-line tape preparation. This accounts in part for the relative simplicity of design of European teleprinters and ASR sets.

Because of the many languages used in Europe most teleprinter manufacturers have adopted symbols for use on function key tops in order to eliminate the need for special key tops with different abbreviations for each language. The symbols used for carriage return and line feed are the same as those sometimes used on tape printing apparatus in this country. The figures-shift symbol is the numeral 1 followed by several dots, and the letters-shift symbol is the letter A followed by several dots. The blank is indicated by a small circle with a short horizontal line inside it.

The trend towards higher speeds did not develop as early in Europe as it did in this country, but there are indications that speeds of 100 words per minute will soon be fairly common in many foreign countries. Both the Siemens & Halske Model 100 and the Creed Model 75 are capable of operation at this speed and these two teleprinters are the most recently designed units available in Europe. The CCITT has not yet adopted a recommended standard modulation rate for 100-wpm operation, but a CCITT Study Group is now considering this problem. There appear to be only two logical choices. One would be adoption of the American standard of 74.2 bauds. With the standard 1.5-unit stop pulse used in Europe, this would result in an actual speed of 593.8 operations per minute and the CCITT standard would be compatible with 100-wpm American teleprinters. The second choice would be to adopt a 75-baud modulation rate. American teleprinters with their 1.42-unit stop pulse could be made compatible with this modulation rate by increasing the speed of operation to 606.2 opm, thereby reducing the unit-pulse length from 13.47 to 13.33 milliseconds. A 75-baud code could be operated with a 74.2-baud code, but there would be a resulting loss of at least 6 percent in the operating margin.

The use of printing telegraph apparatus in integrated data processing is becoming increasingly important in Europe, just as it is in America, and most of the European teleprinter manufacturers are developing special apparatus and accessories for use in IDP. Among the many such accessories being developed for teleprinters are horizontal and vertical tabulation, form indexing, and form feed-out.

The quality of workmanship on all of the European teleprinters is quite good and those tested by Western Union have all performed satisfactorily.

References

1. KEYBOARD STANDARDIZATION, ROBERT W. HARRIS, *Western Union Technical Review*, Vol. 10, No. 1, January 1956, p. 37.
2. TELEX IN NEW YORK, PHILIP R. EASTERLIN, *Western Union Technical Review*, Vol. 13, No. 2, April 1959, p. 45.
3. TELEX IN CANADA, C. J. COLOMBO, *Western Union Technical Review*, Vol. 12, No. 1, January 1958, p. 21.
4. TRANSMISSION SPEEDS AND PULSE LENGTHS OF COMMONLY USED FIVE-UNIT START-STOP PRINTING TELEGRAPH CODES, FRED W. SMITH, *Western Union Technical Review*, Vol. 11, No. 4, October 1957, p. 139.
5. TELEPRINTER CODES: 7-UNIT VERSUS 7.42-UNIT, FRED W. SMITH, *Western Union Technical Review*, Vol 8, No. 4, October 1954, p. 129.
6. CREED MODEL SEVENTY-FIVE TELEPRINTER, BRUCE BROOKE-WAVELL, *Electrical Communication*, Vol. 35, No. 3, 1958, p. 185.

A biographical sketch of the author appears in the July 1953 issue of TECHNICAL REVIEW.

NMAH 310/1

October 6, 1960

MINUTES
FIRST MEETING OF THE X3-2 SUB-COMMITTEE OF THE X3 SECTIONAL COMMITTEE

CODED CHARACTER SETS & DATA FORMAT

I Opening

1.1 The meeting was called to order by the chairman, Mr. I.C. Liggett of IBM at 9:30 a.m. on October 4, 1960 at the ASA Headquarters, 10 East 40 Street, New York City. The following members were present:

R. H. Allen	Moore Business Forms, Inc.
T. H. Bonn	Remington Rand UNIVAC
E. A. Emerson	National Cash Register
R. W. Green	Standard Register Co.
C. E. Macon	Burroughs Corp.
H. L. Marvin	Standard Register Co.
T. S. Mitter	National Cash Register
E. C. Olofson	Royal McBee Corp.
R. W. Reach	Honeywell-Datamatic
L. J. Schoenberg	Monroe Calculating Machine Co.
H. J. Smith	International Business Machines Corp.
H. Tholstrup	Commercial Controls Corp.
B. B. Weber	Addressograph-Multigraph
W. W. Zechel	UARCO, Inc.

1.2 The chairman requested that each member introduce himself, giving a brief description of his background.

1.3 The chairman outlined briefly the history and organization of the X3 Sectional Committee and its relationship to both OEMI and ASA. There was some question at this time of the specific scope and activities of the group. It was agreed that each member would be supplied with copies of the pertinent portions of the Directive for the Data Processing Group of OEMI and sections of the minutes of the January 13, 1960 ASA Meeting at which X3 was formed.

1.4 The chairman appointed Mr. Howard J. Smith secretary, pro tem.

2 Discussion of Group's Activities

2.1 Following discussion of the scope and some of the factors involved in reaching a standard, Mr. Tholstrup described the work of the EIA sub-committees on character codes and data format. It was recognized that much of the work of the EIA group parallels the proposed activities of X3-2. A suggestion was made that Mr. Tholstrup be officially appointed to a liaison position between X3-2 and the corresponding EIA committee. After discussion, it was agreed that it was unnecessary to appoint Mr. Tholstrup. He, in turn, agreed to assume the responsibility in an unofficial capacity.

2.2 Mr. Liggett emphasized that the members of the committee were there in a technical capacity rather than representatives of their particular company or organization. In the discussion that followed, the relationship between ASA committees and the companies sending representatives to the committee were outlined. The procedure to be followed in adopting a standard as outlined in PR-27 was read and discussed. These remarks apparently satisfied the members that positions of their particular companies on these matters would have adequate consideration.

2.3 Mr. Liggett distributed some material relating to the activities and problems of the committee. Mr. Emerson read sections 5 and 8 of the Grems-Mullery report to X3-5 which outlined a suggested procedure. It was agreed that these sections would be distributed to the membership for study and comment at the next meeting.

3. Discussion of Problems

3.1 The group studied and commented on a tabulation of 6-bit codes presently in use in several systems. It was agreed that this material would be reviewed for accuracy by the companies concerned. Further, it was agreed that the representatives of these companies would prepare additions to the table for any machines not included. Mr. Schoenberg presented a copy of a similar study done by the EIA. Mr. Tholstrup agreed to obtain copies of that report for the members of X3-2.

3.2 Two short notes on character set standardization and data format standardization that had been prepared by H. J. Smith were reviewed and discussed. The group reached a tentative outline of an approach to the problem. Essentially this approach is a three-step recursive process:

1. Determine characters desired in a set or subset.
2. Determine the sequence or order of the characters.

3. Considering the medium involved, determine the coded representation of the characters recognizing the control signals required, the methods of specifying data format, and the checking necessary for the medium involved.

3.3 A suggestion was made that copies of the report on Fieldata be made available to the committee members. The secretary agreed to contact Mr. L. L. Griffin of DOD on this matter.

4. Responsibility of Members

4.1 Mr. Liggett emphasized that the committee was a technical working committee. It was pointed out that if an individual felt that he (or his company) was not interested in or directly concerned with the activities of the committee, his withdrawal would be appropriate.

4.2 In answer to a question by Mr. Schoenberg, Mr. Liggett stated that at least at the start approximately 1/5 to 1/3 of a member's time would be required for committee activity. The range would, of course, reflect both the interest of the individual (or company) and the speed with which the committee desires to progress.

5. Objectives

5.1 Mr. Liggett summarized the meeting by suggesting the following objectives:

"Determine external standards in character sets and data format which will facilitate system communications." To this end, the major question seems to be, "Should we modify an existing concept or develop a new concept or concepts? Further, if a new concept is found to be the best approach, what suggestions can be made to facilitate conversion?" It is apparent that the scope of the committee's activities has been defined in broad generalities. It will be necessary for the committee to examine its direction and progress and use these factors to refine its scope.

6. Closing

6.1 The next meeting is scheduled for 9:30 a.m., November 10, 1960 at ASA Headquarters, 10 East 40 Street, New York City.

6.2 The meeting was adjourned at 4:30 p.m.

H. J. Smith
Scretary, pro tem

September 29, 1960

ON CHARACTER SET STANDARDIZATION

It will be assumed that we are concerned with systems using some form of coded character logic internally rather than pure binary machines. This implies that the basic unit of information of a machine is a byte (or collection of bits) and further that within a given byte size all possible valid bid combinations have assigned meanings.

The determination of a standard character set then seems to become a three phase (recursive) process.

1. Organize characters, ideographs, symbols, etc. in an order of precedence (or desirability) for inclusion in a system code set.
2. Arrangement of the characters in all desired sets and subsets into a fixed collating sequence. This sequence must be upward compatible with all larger sets. This is to say that characters of a set must maintain their relative collating sequence when their basic set is included in a larger set.
3. Assign a machine representation to the members of the character set.

Order of Precedence

The following types of characters should be considered.

1. Numeric digits (0, 1, . . . 9)
2. Alphabetic
    a. Upper case English
    b. Lower case English
    c. Greek (because of engineering and mathematical connotations)
    d. Other foreign

3. Special characters
    a. Punctuation
    b. Arithmetic (+ - .)
    c. Other Mathematical
        1. Logic
        2. Algebraic
        3. Calculus
        4, 5. (etc.)
    d. Business Symbols
    e. Miscellaneous Scientific
        (Engineering, Physics, Chemistry, Medicine, Weather, etc.)

4. Control Signals
    (These are system states, not necessarily having symbolic representation in the outside world, which are used to control specified functions or designate special conditions within a system)

Collating Sequence

In general, characters fall into families. Some of these families have a predetermined collating sequence, others do not. In general:

1. Numeric $0 < 1 < \ldots < 9$

2. Alphabetic
    a. Upper case $A < B < \ldots < Z$
    b. Lower case $a < b < \ldots < z$
    c. Foreign (each has preferred sequence)

3. Special Characters
    Generally non-sequenced

4. Control Signals
    Generally non-sequenced

The committee then should consider rules by which non ordered families will be ordered and then rules by which ordering among families will be accomplished.

Assignment of Machine Representations

Two general types of codes seem possible.

1. Dense Codes
    A binary coded byte can be assumed to consist of a number of bits used for information and a number of bits for checking. In a dense code no bit combinations within the information portion of a byte are invalid anywhere within the system. Further, each bit combination should have a unique meaning.

2. Non-Dense codes
    a. Systematic: There is a logical rule by which the validity or invalidity of a character can be determined. The 650, for example, uses a $^2/5$ code set.

    b. Random: Certain characters are invalid but no simple logical rule can be stated for determining whether a bit combination is valid or invalid. This type of code necessitates association of the bit pattern with its graphic representation. BCD machines in which only 10 of 16 possible codes are valid exemplify this type.

Once a character set is determined, control signals defined and collating rules established, the system code set can be devised. The proper byte size is selected, and, if the byte size permits more states than characters plus control signals, additional characters assigned.

It is most important to emphasize that if possible all codes should have unique meaning, that is, there should be a one to one relationship between the code set and the characters of the basic set plus control signals.

The discussions of the committee should also be directed toward determination of the practicality of using two or more characters in combination to represent a single very seldom used character. The two character concept could also be used for an alternate method of obtaining control.

Other problems which will be encountered are those of blank, "idle", and "null" characters, definition and description of control signals and format effectors, and the relationships of the set with foreign alphabets.

bcc: Mr. R. W. Bemer
Mr. H. J. Smith

September 19, 1960

Captain William F. Luebbert
Associate Professor
United States Military Academy
West Point, New York

Dear Captain Luebbert:

The X3 Sectional Committee of the American Standards Association has been given the responsibility for the formation of several standards for the field of data processing. At the August 4, 1960 meeting, I was selected as chairman of the X3-2 Sub-Committee on coded character sets and data format.

Since that time, your work on the FIELDATA code has been brought to my attention. In view of this work, I feel you will be a valuable member of the X3-2 Sub-Committee. I am enclosing the minutes of the first X3 Sectional Committee Meeting to help you assess the objectives and activities of the sub-committees.

The first meeting of X3-2 is to be held at 9:30 a.m. on October 4, 1960, at ASA Headquarters, 10 East 40 Street, New York City. I would appreciate your presence at that meeting, and I hope that your present activities will not prevent you from becoming a member of this group. An agenda is also enclosed.

September 15, 1960

Memorandum to: All Members of X3-2 Sub-Committee

The first meeting of the X3-2 Sub-Committee is scheduled for 9:30 a.m. on October 4, 1960 at ASA Headquarters, 10 East 40 Street, New York. The basic purpose of this meeting will be to make certain that all members of the committee are acquainted with its objectives and functions.

The two task groups, defined by the charter of the group, will be formed, and a tentative plan for action and necessary meetings will be established.

It would probably be desirable for each member of the committee to bring any documents that he feels would be of interest to the group.

If this meeting date conflicts with any prior commitment, I would appreciate hearing of it at your earliest convenience.

I. C. Liggett, Chairman
X3-2 Sub-Committee

ICL:ie
Attachment - Agenda

AGENDA

X3-2 Sub-Committee Meeting - October 4, 1960

A. Purpose and Scope of Sub-Committee

1. Background (including minutes of X3 Sectional Committee at which sub-committees were formed).
2. Short description of groups involved and their inter-relationships.

B. Introduction of Sub-Committee Members

C. Discussion of Overall Objectives

1. What is a standard?
2. What can be standardized?
    a. standard character sets
    b. data format
3. What form will the possible committee recommendations take?

D. Organizations of Task Groups

1. Character Sets
2. Data Format

E. Date and Agenda for the Next Meeting

Suggested Members for X3-2

E. C. Olofson
Engineering Administration Manager
Royal McBee Corporation
1031 New Britain Avenue
West Hartford, Connecticut

W. W. Zechel
Product Manager
UARCO, Inc.
300 West Congress Parkway
Chicago 7, Illinois
HArrison 7-5141

H. Kleinberg
Manager, Computing Devices Engineering
Radio Corporation of America
Electronic Data Processing Division
Camden 2, New Jersey
WOodlawn 3-8000

R. Reach
Minneapolis-Honeywell Regulator Company
DATAmatic Division
151 Needham Street
Newton Highlands 61, Massachusetts
DEcatur 2-6960

R. W. Green
Staff of the Vice President
Engineering and Research Division
The Standard Register Company
Dayton 1, Ohio

H. L. Marvin
Staff of the Vice President
Engineering and Research Division
The Standard Register Company
Dayton 1, Ohio

T. H. Bonn
Remington Rand UNIVAC
19th and West Allegheny Avenue
Philadelphia 29, Pennsylvania
BAldwin 3-0600

H. J. Smith
Corporate Logical Systems Standards
IBM Corporation
112 East Post Road
White Plains, New York
WHite Plains 9-1900

E. A. Emerson
Design Specialist
The National Cash Register Company
Electronics Division
1401 East El Segundo Boulevard
Hawthorne, California
PLymouth 7-1811

T. S. Mitter
Product Planning Department
The National Cash Register Company
Dayton 9, Ohio
BA 6-1411

R. H. Allen
Product Planning Manager
Research Division
Moore Business Forms, Inc.
1001 Buffalo Avenue
Niagara Falls, New York
BUtler 5-6931

W. S. Nivison
Recordak Corporation
343 State Street
Rochester 4, New York
BAker 5-9019

C. E. Macon
Systems Department Section
ElectroData Manufacturing and Engineering Division
Burroughs Corporation
6071 Second Avenue
Detroit 32, Michigan

L. L. Griffin
Electron Engineer
Navy Management Office
Department of the Navy
Washington 25, D. C.

A. Nike
Addressograph-Multigraph Corporation

L. Schoenberg
Monroe Calculating Company

H. Tholstrup
Friden

ICL:VMG
9-15-60

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selected as chairman of the X3-2 Sub-Committee on coded character sets and data format.

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The first meeting of X3-2 is to be held at 9:30 a.m. on October 4, 1960, at ASA Headquarters, 10 East 40 Street, New York City. I would appreciate your presence at that meeting, and I hope that your present activities will not prevent you from becoming a member of this group. An agenda is also enclosed.

Very truly yours,

ICL

I. C. Liggett, Director
Systems Standards
Chairman X3-2

ICL:VMG
Enclosures

ELECTRONIC INDUSTRIES ASSOCIATION
REPORT OF MEETING OF THE
TR-24.4 SUBCOMMITTEES ON LANGUAGE AND FORMAT,
PUNCHED TAPE, MAGNETIC TAPE AND TABULATING CARDS

TR-24.4.1
TR-24.4.3
TR-24.4.5

October 11, 12, & 13, 1960 Conrad Hilton Hotel Chicago, Illinois

TR-27.6.2 (Formerly TR-24.4.1) TR-27.6.3 (Formerly TR-24.4.3)

MEMBERS PRESENT

Charles D. Whitaker	National Cash Register,
F. A. Williams	IBM, White Plains, New York
H. Tholstrup	Commercial Controls Corp.
E. L. Rogers	General Electric, Schenectady, New York
John Auwaerter	Teletype Corp., Skokie, Illinois
John Nelson	Western Union
Thomas McNamara	Minneapolis Honeywell
Raymond A Skov	IBM, Poughkeepsie
Erwin Budde	National Cash Register
Carl Toeneboehn, Chairman	Emerson Electric, St. Louis, Mo.

The meeting of TR 24.4.1 was called to order at 9:15 A.M. October 11, 1960.

The results of the ballots on the tentative proposal for a Basic Character Set Code were 8 opposed, 13 approvals and 1 abstaining.

Opposed

1.	J. M. Morgan	Cincinnati Milling Mach. Co.
2.	E. o. Blodget	Commercial Controls Corp.
3.	D. B. Schneider	G.E.Co. Spec. Cont. Dept.
4.	M. V. Hayes	Jones & Lamson Mach. Co.
5.	E. Lieblein	U. S. Army Signal Corp. R & D Lab.
6.	L. Herchenroeder	Westinghouse Electric Corp.
7.	L. L. Griffin	Dept. of Navy
8.	J. H. Sweer	RCA Bldg. 82-1

Abstaining

T. J. McNamara	Minneapolis-Honeywell, Datamatic Div.

Approvals

1.	G. M. Ives	RAMO Wooldridge
2.	G. K. Burns	Teletype Corp.
3.	A. C. Reynolds	Stromberg Div. of General Time Corp.
4.	J. E. Lisinski	IBM Corp. D591 San Jose, Calif.
5.	E. G. Newman	IBM Prod. Dev. Lab., Poughkeepsie, New York
6.	R. F. Dean	IBM Dept 299, Endicott, New York
7.	Wm. A. Bezaire	Rich Electric Comp. Cont., G.A. Tech.
8.	R. O. Rutherford	RCA Camden N. J. Bldg 13-1
9.	R. A. Von Behren	Minn. Mining & Mfg. Co.
10.	J. H. Craig	Amer. Tel & Tel Company
11.	R. R. Spalholz	Fairchild Graphic Equipment
12.	E. F. Carlberg	Boeing Airplane Company, Seattle
13.	C. Toeneboehn	Emerson Electric Mfg. Co.

The pertinent portions of the letters of comment are abstracted in the following paragraphs:

"As I have stated in the past, we are in favor of a Hollerith oriented code because of the volume of equipment in the field and also the ease of conversion. Once having deviated from the Hollerith code, we feel that each of the proposed sets of codes has equal merit.
Therefore, we have chosen not to vote on these tentative proposed standards." - T. J. McNamara, Minneapolis-Honeywell Regulator Co., Datamatic Division, Newton Highlands, Mass.

"It is believed Fieldata (code C) is better choice; its disadvantage with respect to (A) are very minor" - J. H. Sweer, RCA Bldg. 82-1

"The criteria adopted should lead to a code similar in structure to the Fieldata Code, as, I'm sure, you are well aware. It would be a regretable circumstance if industry and The Department of Defense were to adopt standard codes that were similar in structure but differing in details unless valid and substantial reasons exist for such differences. I do not now see such reasons and hold the belief that we, meaning industry and military representatives, should co-operate to prevent such a circumstance from occurring." - L. L. Griffin, Navy Management Office, Washington, D.C.

"We do not approve of the proposed standard for a Basic Character Set Code because the codes selected for the letters are unnecessarily arbitrary and hard to remember. The letter A is binary six while Z is thirty-one. Presumably, this is to put Z next to numeral zero, which is thirty-two, in accordance with criterion H that numerals shall be contiguous to letters. We see no merit in Criterion H. Presumably, Criterion H is to aid sorting but if punctuation or control characters do occur between the letters and numbers, one would never find them in words or numbers to be sorted.

If Criterion H is dropped, a very simple and elegant code becomes possible, and fulfills all the other criteria. The preferred code would be as follows: 000001 to 011010 letters; 100000 to 101001 numbers; 110000 to 111111 punctuation.

The code for each letter is simply its order in the alphabet, expressed in binary. The first letter A is binary one or 000001. The fourth letter D is binary four or 00100. Z is binary twenty-six. Nothing could be simpler to remember or reconstruct.

If punctuation is not being used, as would often be the case, letters and numbers can be distinguished by the first bit alone, whereas the proposed standard requires the first two bits. So our code better fulfills Criterion F.

In most applications the characteristics 000000, 011010 to 011111 (5 characters), and 101010 to 101111 (6 characters) would be unused, leaving 52 used characters out of 64, which is more than are available on most keyboards. Under these circumstances even Criterion H would be fulfilled. The numbers would effectively be contiguous to the letters since the characters in between would be unused.

UMAH
30/11

If a shift key is used for upper and lower case it should have a seventh track assigned to it. This is in accordance with Criterion G that each code will stand by itself. The present Flexowriter code, where there is a latched or memorized code, is objectionable, as is the wasteful use of a whole track for the one character "End of Line" - M. V. Hayes, Jones & Lamson Machine Company, Springfield, VT.

"Some of the reasons for not approving this standard are as follows:

1. It is our belief that the numerics precede the alphabet instead of follow it as set forth in your Criteria "J".
2. We would propose that, since numeric figures are most often used, these be definable by the least number of binary bits.
3. It is our feeling that the order of importance of the code with respect to ascending numbers of bits should be numeric, alphabetic and symbols.
4. We feel that is is extremely important that the ease of differentiation between numeric and alphabetic be maximized. This has enough importance in our work to render Criteria "A" to the category of secondary importance.

Although our work does not extend into the field of communication and data processing equipment to any degree, it is felt that the importance of the above to the numerical positioning and contouring control equipment is important enough to warrant a "do-not-approve vote". - D. B. Schneider, Speciality Control Dept., General Electric Company, Waynesbora, Va.

"We do not approve because we do not see the merit of Criteria H. Why should the numerals be contiguous with the alphabet? We would suggest dropping Criteria H and base the code as proposed by Miles Hayes. We think such a code would be much easier to recognize and use than Code A, B or C as shown in the tentative standards proposal, and agree with the reasons given by Mr. Hayes". - J. M. Morgan Development Research Dept, Cincinnati Milling Machine Co., Cincinnati, Ohio.

"Prefer Code B so that complete hexadecimal characters can be in order" - L. W. Herchenroeder, Westinghouse Electric, E. Pittsburg, Pa.

"From a computer applications and a programming standpoint, I find the proposal completely acceptable. This is something that is needed as the present collating sequences (or code sequences) require more programming and computer time to achieve a sorted file in the desired order" - J. Egler, Emerson Electric Mfg. Company, St. Louis, Missouri."

"1. The code as presented is not complete in its organization.
2. The proposed code is incompatible with Fieldata Code - -
3. Contiquity of alphabetic characters and numeric characters (Criteria H) is not desired by the Government and the military in a standard code for the following reasons:

a) Alphabet expansion: such contiquity will prevent the use of a language with a longer alphabet than English. This is a definite requirement. The government must be capable of expanding the alphabetics to provide filing and collating of information in a language other than English. The Fieldata code permits expansion of the alphabet into a symbol portion which while destroying some symbols does not destroy the numbers.

b) The Government plans to use a pseudo-Fieldata in modulo 5 form where bits 7.6 and 5 of the code are eliminated. Such a code can be easily generated by simple modifications of teletypewriters involving replacement of the selector bars. This would provide for case operation (figures and letters) which would eliminate the symbols whose 5 bit equivalent are the same as master space, upper case, lower case, line feed, carriage return and space. If the letters and numbers were contiguous, such operation would not be possible without destroying the numbers. In this case, some symbols are sacrificed for to achieve a very valuable interpretation between both Fieldata and teletype equipments - - E. Lieblein, U. S. Army Signal, R & D Lab., Fort Mammouth, N.J.

The above letters of comment incited much discussion among the members present concerning the position of the numerals in the basic character set. It is apparent that criteria for selecting the basic character set must be weighted as to their relative importance. It was concluded that more data was needed from industry on the existing data files before this could be done intelligently. The chairman was instructed to prepare a questionaire to be used as an industry survey. Mr. F. A. Williams and Mr. T. J. McNamara agreed to submit the list of questions for this survey. It was agreed that the survey be made from the Fortune Magazine listing of the top 500 Industrial Corp. 50 largest banks, transportation, life-insurance companies, etc.

Mr. Tholstrup also reported on the OEMI committee activities on language and format.

The committee adjourned following agreement on the next tentative meeting date of December 13, 1960 in New York, N. Y.

TR 27.6.1 (formerly TR 24.4.4)

Members present

C. D. Whitaker	National Cash Register
F. A. Williams	IBM White Plains
H. Tholstrup	Commercial Controls
E. L. Roger	General Electric, Schenectady, N. Y.
John Nelson	Western Union

The meeting of TR 24.4.4 committee was held on Wednesday October 12, 1960 during which the general subject of cards and card codes was discussed. Mr. Whitaker is to receive from each member present all information on hand concerning card coding and code arrangements - domestic and foreign. These are to be arranged for discussion, along with card material standards at the December meeting.

TR 24.4.5 (Now included in TR 27.6.2)

Members Present

F. A. Williams	IBM, White Plains, N. Y.
H. Tholstrup	Commercial Controls Corp.
E. Rogers	General Electric Corp.
John Auwaerter	Teletype Corp.
John Nelson	Western Union
J. Lisinski	IBM, San Jose, Calif.

A meeting was held on Thursday October 13, 1960 of the TR 24.4.5 committee. The ballots and comments received on the 11/16 wide tape tentative standards were reviewed. A task group was formed to prepare 20:1 enlargement layouts of the mean dimensions with the range of tolerances shown for each of the options indicated to provide a visual aid for evaluating the merits and limitations of each of the options. If satisfactory, these could be included in the background section accompanying a new ballot on the subject.

Mr. J. Nelson reported that the 11/16 inch tape subject may not be of much consequence in the future, as there has been a noticable increase in the use of one inch tape in business machines where 5 hole Baudot code is used and EIA standard RS 227 may be all that is required.

Respectfully submitted,

Carl Toeneboehn

C. Toeneboehn

Undetected Errors in 5-Unit Code Transmission and Their Elimination

James F. Holmes
Lybrand, Ross, and Montgomery
New York 4, N.Y.

A great many articles are being published concerning data communications as input-output media to data processing operations. The majority of them cover high-speed communications using microwave and 6, 7, and 8 unit codes with speeds in excess of 3000 bits per second. What about the old work horse, the five-unit code for telegraphic communications up to 100 words per minute?

The five-unit, or Baudot, code has been in use for a long time. Telegraphic communications serve a definite need, especially for those who require continual communications for general as well as for data purposes and whose operations are scattered and individually not large enough to support high-speed equipment.

Admittedly, the Baudot code causes some problems, especially in detecting errors. There is, however, a solution and, wonder of wonders in this day and age, the costs of the solution are either negligible or zero. The following discussion deals with the solution to the "undetected" error problem.

The tests referred to were run by Western Union Telegraph Co. American Telephone and Telegraph has stated that they will participate in a code reassignment discussion if enough interest can be generated. Work in the area of code reassignment is now being done in Europe on the basis of a complete change. This paper proposes a code called the "L" code which appears to be the simplest and to require the least number of changes. A system will be installed in late 1960 in the United States using the "L" code.

The 5-Unit Baudot Code

The punched paper tape 5-unit Baudot code has been in use in telegraphic communications for approximately 80 years, and has proved reliable for administrative message traffic. However, data transmission requirements in recent years have shown certain inadequacies existing with the standard Baudot code assignments.

The original assignment of codes was made on the basis that the most commonly used letters should be assigned the simplest codes. This assignment leads to some rather peculiar and interesting transmission errors. Table 1 shows a standard assignment of coding.

How will a character be changed upon the loss or of a single pulse? It is possible to make a schedule just which characters will result from a given char the gain or loss of a single pulse.

Control codes for data transmission must be chosen carefully, as will be noted from such a schedule.

Errors

For example, a particular data application demons unfortunate choice of control codes is the choice of M one function and N to denote an opposite function. instance, "M" may be used to denote manual input ing special handling or card insertion at the data while "N" may denote normal input for fully processing. The code for M is – – 0 0 0; the for N is – – 0 0 –; accordingly, an "M" or "N" be changed each to the other through the loss or gain single pulse (one to the other) in the standard code ment.

More complicating errors are possible with the ment of upper case (numeric characters). The loss or of a single pulse will convert

5 to 9
8 to 7 or 0
9 to 5
7 to 1 or 8

0 to 1 or 8
2 to 1
6 to 1
1 to 0, 6, 2 or 7

This is a vast array of possible numeric to numeric which are difficult to detect under the most ideal and may in themselves produce compensating errors. possibility of these simple changes which may be sating has raised the demand for error-detecting from every quarter.

Error Detection and Correction

The equipment manufacturers are willing and produce error-detecting and error-correcting devices. designs are presently available and some have been eted. However, basic economics indicate that there no mad rush to install such devices. Inasmuch

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Table 1

5-UNIT CODE — STANDARD "A" CODE ASSIGNMENT

the codes as shown, a "0" stands for a punched hole a pulse and a "–" stands for or no pulse.)

	Code					Meaning	
	1	2	3	4	5	Lower Case	Upper Case
Singles:	0	–	–	–	–	E	3
	–	0	–	–	–	LINE FEED	
	–	–	0	–	–	SPACE	
	–	–	–	0	–	CAR RET	
	–	–	–	–	0	T	5
Double	0	0	–	–	–	A	—
	–	0	0	–	–	I	8
	–	–	0	0	–	N	,
	–	–	–	0	0	O	9
	0	–	0	–	–	S	'
	–	0	–	0	–	R	4
	–	–	0	–	0	H	#
	0	–	–	0	–	D	$
	–	0	–	–	0	L	)
	0	–	–	–	0	Z	"
Triples:	0	0	0	–	–	U	7
	–	0	0	0	–	C	:
	–	–	0	0	0	M	.
	0	–	0	0	–	F	!
	–	0	–	0	0	G	&
	0	0	–	0	–	J	BELL
	–	0	0	–	0	P	0
	0	–	–	0	0	B	?
	0	0	–	–	0	W	2
	0	–	0	–	0	Y	6
Quadruples:	0	0	0	0	–	K	(
	–	0	0	0	0	V	;
	0	0	0	–	0	Q	1
	0	–	0	0	0	X	/
	0	0	–	0	0	FIGURES	
Quintuple:	0	0	0	0	0	LETTERS	
Blank:	–	–	–	–	–	BLANK	

ber of errors generated in the communications system relatively small, some of the economic factors to consider

1. The human error rate in data creation is the biggest variable.
2. Communications-equipment error rate is lower than that in the conventional data-conversion equipment, such as tape-to-card converters.
3. The information transmitted is, in almost every case, accounting information made up of a vast number of individual problems. Error rates are tolerated on a conventional tabulating processing system; and the communications system does not normally introduce any appreciable change in the tolerable error rate.

Errors fall into two general categories, i.e., *detected errors,* and *undetected errors.* In communications terminology generally a detected error is one in which a character is changed to a completely invalid or non-sense character; and an undetected error is one in which a character is changed to another valid character such as numeric converted to numeric. A relatively high detected-error rate may be tolerable while an undetected-error rate of any magnitude is intolerable. If it is assumed that normal detectable transmission error rates are tolerable in present accounting applications, it then is necessary to eliminate the relatively small proportion of undetected errors.

Most available error-detecting devices require manual intervention and are generally inefficient in "line time." The system may be one in which transmission continues until an "end of block" signal indicates a check point, at which time an error may be detected, stops both the transmitter and the reperforator and, at the same time, actuates a visual and audible signal. The signal calls an operator, who manually resets the received tape to the end of the previous block, "letters out" the errored block and signals for a re-send of the errored block. This type of operation may prove satisfactory in point-to-point transmission where high utilization of equipment and circuitry is not a requirement but, in any case, it is an inefficient use of personnel, equipment and circuits and is not practicable for "switched" tape systems.

Many systems, even those large enough for switching operations, cannot afford the personnel time, equipment or circuits necessary to ensure "error free" transmissions. Frequently, private wire telegraph systems are installed for transmission of both administrative and data messages, on the theory that the data will "ride free" on previous administrative communications costs. This means high utilization of circuits, personnel, and equipment.

Requirements for Ideal Error Detection

The ideal error detection system for data messages on a 5-unit telegraph system, whether it be TWX, WUX, Telex or private wire, will have the following characteristics:

1. Will cost nothing
2. Will not add to line time
3. Will eliminate compensating errors
4. Will indicate all errors
5. Will provide for message reconstruction at the receive end.

Results of Tests

Recent studies have indicated that an error detection system is possible which will closely follow the above five requirements. These studies have shown that:

1. Ninety percent of all errors are the result of the loss or gain of a single pulse with about 88 percent being the loss of a single pulse;
2. Individual circuits exhibit a general pattern; for example, an error on a particular circuit may generally be the loss of the fifth pulse;

3. Error rates for data me[illegible] a telegraph communications system can [illegible]w as 1 in 500,000 characters;

4. Undetected errors are about [illegible] in 7 of all errors.[1]

The economic problems involved in providing low-cost error detecting devices, coupled with the generally low incidence of error in normal telegraphic communications, indicates that an approach other than additional equipment is needed to overcome the undetected error problem. A recent study has shown that a system does exist within the structure of the 5-unit code to reduce the undetected error rate to a maximum of 1 in 500.[1]

Reassignment of Coding

In the Baudot code (Table 1), the fact that almost all errors are the result of the loss or gain of a single pulse, coupled with the 5-channel code configuration, provides an economical solution to the undetected error problem. The solution is a reassignment of coding to place all numeric characters into the 10 triples. The keyboard layout remains the same.

The coding reassignment requiring the least mechanical change is an exchange of six pairs of characters listed below:

J and R	C and I	G and Q
B and O	E and F	M and T

A calculation shows that this code reassignment would prevent the change of a numeric character to another numeric character through the loss or gain of a single pulse. Further analysis, however, shows that an exchange of vowel for vowel has also been eliminated, with the exception of a possible change of an A to U and vice versa. In order to keep the cost of mechanical coding changes to existing equipment at a minimum, it may be assumed that the elimination of the A to U possibility may be disregarded.

In order to follow through with the reduction of undetected alphabetic errors, it would be desirable to eliminate such errors as changing *full* to *fall, fur* to *far, Jun.* to *Jan.;* so it is reasonable to propose one additional subsequent coding change, A and F. A calculation then shows no change of vowel to vowel or numeric to numeric for the loss or gain of any single pulse. In other words, when an error is encountered, the proposed coding change will yield a consonant for a vowel and vice versa or, in the case of numerics, a non-sense or invalid character in place of the numeric, thus virtually eliminating compensating numerical error possibilities. Numerical errors may be easily detected in existing tape-to-card and tape-to-magnetic-tape converters, computers and other devices, using the proposed reassigned coding.

The L Code

The actual resulting changes in the A code, producing the L code, are shown in Table 2.

The effect of the L code can be shown in an illustrative example as follows, assuming an extremely poor system with an error rate of 1 in 10,000 characters, consisting of 14 circuits operating at 75 words per minute, 9 hours per day at 90% utilization:

Condition	The A Code	The L Code
100% transmission	3,402,000 char/day	3,402,000 char/day
90% utilization	3,061,800 char/day	3,061,800 char/day
Errored characters	306 char/day	306 char/day
Undetected errors	44 char/day	0* char/day

* (An undetected error might be expected once every 11 days on the basis of a maximum rate of 1 in 500.)

Table 2

Code					Meaning	
0	–	–	–	–	A	—
–	–	–	–	0	M	.
0	0	–	–	–	F	!
–	0	0	–	–	C	:
–	–	–	0	0	B	?
–	0	–	0	–	J	BELL
–	0	0	0	–	I	8
–	–	0	0	0	T	5
0	–	0	0	–	E	3
–	0	–	0	0	Q	1
0	0	–	0	–	R	4
0	–	–	0	0	O	9
0	0	0	–	0	G	&

The proposed reassigned coding (referred to hereinafter as "L" — for "logical" — code) is essentially a data transmission requirement. It is not to be expected that existing 5-channel systems would be changed to the "L" code immediately or in the foreseeable future but, rather, that "off-line" data conversion equipment be changed. There is, however, no reason not to install entire new systems which would use the "L" code.

Equipment is presently available which can be used "off-line" for transmission in the standard code for administrative purposes and includes the use of a third shift to provide numeric data transmission in a reassigned code.[2]

Loss of Complete Characters

There is an additional area of error in data transmission that is encountered in normal operation. This is the loss of a complete character, shifting data out of field without actual loss of any significant digit by such happening as the dropping of spaces affecting the field which defines a numerical unit. For example, a 1 shifted a column to the left will be interpreted by computers or data equipment as 10.

A simple pulse generator connected to the receiving line will keep the receiving equipment in synchronization at the previous rhythm before loss of line signal. This will maintain synchronization upon restoration of the line signal, and will insert blanks for the lost characters in the received tape. The blanks can then be detected as errors using other equipment.

he A Code	The L Code
2,0 char/day	3,402,000 char/day
1,800 char/day	3,061,800 char/day
3 char/day	306 char/day
44 char/day	0* char/day

igh be expected once every 11 d rat f 1 in 500.)

Tal 2

	Meaning	
- —	A	—
-	M	.
.	F	!
. —	C	:
	B	?
	J	BELL
—	I	8
	T	5
	E	3
	Q	1
—	R	4
	O	9
	G	&

---

co g (referred to hereinafter ode) is essentially a data-trans ot to be expected that existing c ged to the "L" code im ble ture but, rather, that "of pment be changed. There is stall entire new systems which

ail le which can be used "on standard code for administra he e of a third shift to pro ior a reassigned code.[2]

lete Characters

o rror in data transmission l operation. This is the loss ing data out of field without d by such happenings as ng e field which defines the a r shifted a column to the omputers or data equipment

on cted to the receiving leg nent in synchronization with oss of line signal. This will n toration of the line sig th ost characters in the re then be detected as errors

The cost of the pulse generator or teleprinter synchroni set[3] will be proportional to the number of start-stop es that must be generated upon signal loss. Equipment esently available that will generate up to 20 start- pulses[3] but for normal day-to-day operation syn- izing equipment producing 3 to 5 start-stop pulses d be sufficient. Radio transmissions would require the er-order teleprinter synchronizing set.

small nexpensive pulse generator could be incor- ed within the receiving unit distributor circuitry at a minor increase in monthly rental.

e teleprinter equipment most readily adaptable to the ding is the type 28 line of teleprinter equipment actured by the Teletype Corporation. Studies are ntly under way to determine the cost of conversion of ng ty 28 equipment.

her e data-preparation equipment may be ob- ed fro e manufacturer using the "L" coding at no ase in sts. Tape-to-card converters can be made able to the "L" code through the plugboard.

Summary

The "L" code will provide the following:

1. R id error detection
2. F bility of message (character) reconstruction at e receiving end
3. Available at little or no cost
4. Can be transmitted on existing systems utilizing off-line equipment for data preparation
5. Will eliminate undetected errors
6. Will eliminate compensating errors
7. es not increase line time.

The proposed adoption of the "L" code does not provide on-line error correction, which is felt to be time con- ming and uneconomical. The inclusion of teleprinter chronizing circuitry with the receiving distributor will intain synchronization upon loss of the line signal.

The adoption of the "L" code and inclusion of a simple eprinter synchronization device would virtually eliminate problems existing in transmission of data using standard eprinter circuits and equipment.

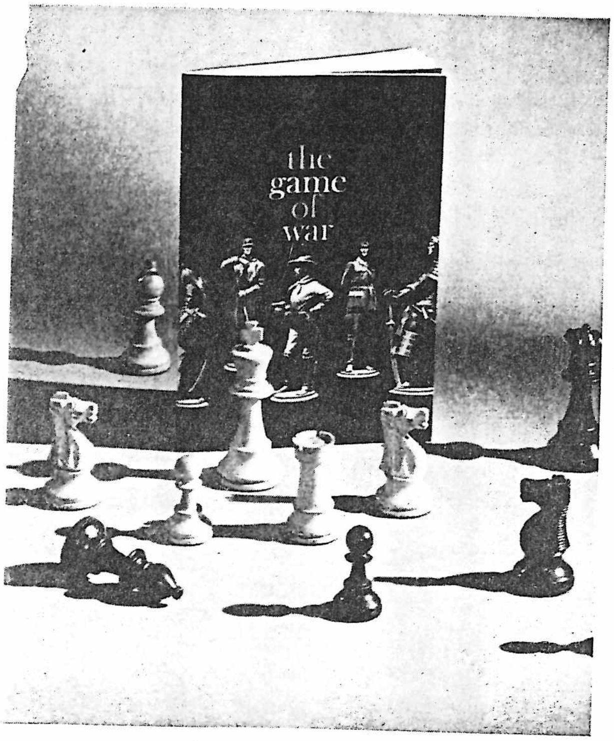
Notes

Error-Checking Possibilities Concealed Within the 5-unit Code*, by R. Steeneek, Western Union Technical Review, Vol. 14, No. , April, 1960, pp. 69-71.

Teleprinter for Reliable Transmission of Numbers, by S. Au- ustin, Electrical Communications, Vol. 35, No. 4, 1959, pp. 245-246.

Teleprinter Synchronizing Set SYZ-634, by W. Schiebeler, Electrical Communications, Vol. 35, No. 4, 1959, pp. 247-250.

The author acknowledges with gratitude the assistance The Western Union Telegraph Co. in obtaining test data.



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Synthetic history, they call it: the application of advanced mathematical thought, and the digital computer simulation of war or in support of map battles, have brought *Project Omega* to the frontiers of new developments in gaming, for Army, Navy, Air Force, OCDM and ARPA, as well as business and industrial sponsors.

For your free copy of THE GAME OF WAR, an illustrated history of the highlights of war gaming over 3,000 years, illustrated with authentic warriors of the periods, write to James L. Jenkins.

Technical Operations, Incorporated

tech/ops

3600 M Street Northwest Washington 7, D. C.

X3-2 Sub-Committee
on
Character Sets & Data Formats
of the
American Standards Association
X3 Sectional Committee
Sponsored by
O.E.M.I.

November 15, 1960

MINUTES

#2 MEETING OF NOVEMBER 9, 1960

1. Membership

MEMBERS

Present:

- Leon Bloom - NCR
- Theodore H. Bonn - Remington Rand
- Everett A. Emerson - NCR
- Robert W. Green - Standard Register Co.
- L. L. Griffin - Navy Department
- I. C. Liggett - IBM
- C. E. Macon - Burroughs Corporation
- E. Clifford Olofson - Royal McBee Corp.
- Roy W. Reach - Minnesota-Honeywell
- Lawrence J. Schoenberg - Monroe Calculating Machines
- H. J. Smith, Jr. - IBM
- H. Tholstrup - Friden Incorporated
- B. B. Weber - Addressograph-Multigraph Corp.

Not Present:

- W. S. Nivison - Recordak
- H. Kleinberg - RCA

CHANGES IN MEMBERSHIP

Mr. Bloom replaces Mr. Emerson for NCR.

Mr. Mitter will serve as Mr. Bloom's alternate.

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CHANGES IN MEMBERSHIP (continued)

R. H. Allen - Moore Business Forms, Inc. - Voluntarily submitted his resignation.

H. L. Marvin - Standard Register Co. - Voluntarily submitted his resignation.

W. W. Zechel - UARCO, Inc. - Voluntarily submitted his resignation.

2. The meeting was called to order by the Chairman at 9:30 a.m.

3. Mr. Bloom and Mr. Griffin were introduced and gave a brief account of their backgrounds.

4. The Chairman announced a meeting involving the Chairman and Secretary of each X3 Sub-Committee to be held on November 10, 1960. This meeting is intended to serve as an indoctrination of those involved, covering such items as procedures to be followed, contents of minutes, legal implications of sub-committee activities, etc.

5. It was noted that the activities of the X3-2 Sub-Committee were closely connected with, and in certain areas overlap, the activities of the Character Recognition (X3-1), Problem Oriented Language (X3-4) and Data Transmission (X3-3) sub-committees. The Chairman noted that coordination of the various activities was the task of the X3 Sectional Committee and that each sub-committee was dualy represented on the Sectional Committee by its Chairman. It was further noted that close liaison with the other sub-committees would be required on a working basis for certain areas of the activity.

6. The minutes of the last meeting were read and approved.

7. Selection of a secretary was the next order of business. C. E. Macon was elected to this office.

8. The material which has been issued to date was quickly reviewed. This material consists of:

8.1 PR27, 6th Edition, April 5, 1960

"The organization and work of Sectional Committees operating under the Constitution, By Laws and Procedure of the American Standards Association, Incorporated."

8.2 "A Short Study of Notation Efficiency," by H. Smith

8.3 "On Data Format Standardization," by H. Smith

8.4 "On Character Set Standardization," by H. Smith

8.5 Minutes of ASA General Conference of January 13, 1960.

8.6 ASA Sectional Committee Meeting of August 4, 1960, Agenda and Minutes.

8.7 Grems-Mullery Report Extract.

8.8 "A Survey of Coded Character Representation," by R. W. Bemer of IBM. (Complete with chart of codes for various machines.)

8.9 "Fieldata Equipment Intercommunication Characteristics," memorandum for: Director, Data Processing, Facilities Division, Communications Department, USASRDL of April 1959 (Rev. August 1, 1959).

8.10 "Proposed Addendum to Section 3 of MILSTD-188A," supplied by Mr. Griffin.

8.11 "Random Thoughts on Characters and Set Sizes," by H. Smith.

8.12 "Remarks on Blank, Null and Idle," by H. Smith.

8.13 It was noted that:

  8.13.1 The "Fieldata" report is not to be reproduced.

  8.13.2 There is an ~~amendment~~ addendum due on "Fieldata" possible in December.

9. A question was raised on review of sub-committee proposals and recommendations by O.E.M.I. Engineering. The following points were made:

  9.1 The O.E.M.I. as a sponsor of the ASA X3 Sectional Committee has the responsibility to see that proper representation is established on the X3 Committee. This has been accomplished by requiring a committee membership of six manufactures, 7 users and s7x general interest.

  9.2 The O.E.M.I. is essentially represented by the six manufacturers on the X3 Committee.

  9.3 The sub-committees are comprised of experts in the field and are to submit recommendations to the X3 Sectional Committee. While these experts are affiliated with certain firms and/or organizations, it is expected that they will "divorce" themselves from such affiliations for purposes of conducting the work of the sub-committee.

10. A strong note of urgency in completing Phase I of the activity was identified and is based upon:

  10.1 The exploding population of Data Processing Systems and associated equipment.

  10.2 The resulting user requirement for inter-system communication.

  10.3 The increased pressure to create world standards through the ISO and IEC.

11. Considerable discussion ensued as to the definition of "Phase I" and the target date for its completion. The following points were made:

  11.1 In identifying standards speed should not be attained through sacrificing quality.

  11.2 The product of the X3-2 activities will undoubtedly be a family of standards rather than a single standard. This family may be based on media, elements (i.e., character array, sequence, coded representations etc.), time (i.e., current, future and ultimate), etc. These considerations were postponed until more work has been accomplished.

  11.3 It was identified that the problem has at least two elements:

    11.3.1 Inter-system communication employing a particular medium

    11.3.2 Communication from one medium to another.

  11.4 It was suggested that the data presented in the Bemer chart be reorganized in two ways:

    11.4.1 Using media as the independent variable.

    11.4.2 Using the character array as the independent variable.

  Action: Mr. Smith will investigate.

  11.5 It was suggested that the entire Grems-Mullery Report would be excellent background for the sub-committee.

  Action: Mr. Bonn will obtain copies for the members.

  11.6 It was suggested that an attempt be made to identify standards for punched cards and magnetic tape for the current situation to be closely followed by standards for paper tape and printer output on the same basis; such standards to be identified within a few months and followed by a future set. The terms "current" and "future" were discussed at some length and the following conclusions reached:

    11.6.1 A character array must be established before any standard can be identified. Further, considerable study must be given to the general aspects of sequence and code.

11.6.2 In defining a standard for one ~~xxxxx~~ medium, the impact of the standard on other media (and visa versa) must be identified.

11.6.3 The demands of Problem Oriented Languages, Data Transmission and Character Recognition must be recognized.

11.6.4 A significant amount of valuable work can and should be accomplished before the terms "current" and "future" are defined. In fact, such work will aid measurably in defining these terms.

11.7 It was identified that a standard covering the present situation (i.e.,) an interim standard), while presenting certain problems, would have value and be of reasonable use.

11.8 It was noted that the next ISO meeting would be held in June or July 1961.

11.9 It was felt that X3-2 must demonstrate concrete progress by that time and hopefully have identified a limited family of recommended standards.

12. The above discussion was concluded with the decision to undertake the character set study as outlined in the agenda.

13. Results of discussion identified by agenda item number.

NOTE: The agenda was re-identified as follows:

Item 5.4.6 - Delete

Item 5.5 - Machine Oriented Functions

Item 5.5.1 - Data Control

Item 5.5.2 - Machine Control

Item 5.6 - Sub-set sizes which must be considered.

*5.1 Definition of Terms

*5.1.1 Character Sets

a. The character set will be comprised only those meaningful (to a human) graphies and hieroglyphics.

b. The code set will include certain control functions as well as this character set.

c. No exactitude will be attempted in defining the character representation in printed form.

*5.1.2 Order of Precedence

An order of precedence will be established based on the most desirable order for use in data processing applications (within reasonable limits).

*5.1.3 Case

Consideration of case will be limited to the alphabetic set.

*5.1.4 Other

No additional considerations were identified at this time.

*5.2 Desired Characteristics of Numeric Set

*5.2.1 Number base - Decimal

*5.2.2 The decimal set will be expanded to include plus, minus and radix point.

*5.2.3 Re-defined to identify the sub-script and super-script problem. No recommendations were made. Problem to be studied at the next meeting.

*5.3 Desired Characteristics of Alphabetic Sub-Set

*5.3.1 Multiple Case or Font

Font was eliminated as a consideration at this time and identified as a problem for X3-1 (Character Recognition). Case was limited to upper case and lower case.

*5.3.2 Punctuation

The following are to be considered for inclusion in the alpha set: period, comma, semicolon, colon, question mark, exclamation point, left and right parenthesis, slash, single quote, double quote, hyphen and underscore.

*5.3.3 Foreign Alphabets

At this time consideration will be given only to the English alphabet.

Action: Mr. Tholstrup will obtain copies for each member of the Mackelroy Report on Foreign Alphabets as information and background.

Mr. Smith will obtain copies for each member of a report now being prepared in IBM-WTC on the subject when it is complete.

*5.3.4 (Added) The sub-script and super-script problem as applied to the alpha set is to be studied by each member and recommendations made at the next meeting.

*5.4 Special Characters

Each member is to prepare a basic list for each item structured in precedence order for the next meeting. In addition, a detailed study is to be completed and reported at the next meeting as assigned below:

*5.4.1 Punctuation - Olofson
*5.4.2 Business - Bloom
*5.4.3 Math - Smith
*5.4.4 Engineering - Reach
*5.4.5 Science - Reach
*5.4.6 Circuit Diagrams - Smith, IBM-DA and Macon, Burroughs DA
*5.5.1 Data Control - Schoenberg
*5.5.2 Machine Control - Schoenberg

In addition, Mr. Bonn will obtain a statement of Character Set Size and Contents from the POL Committee (X3-4).

*These numbers refer to the Discussion Guide.

14. Discussion of the remaining points on the agenda will take place at the next meeting. Mr. Griffin will undertake a preliminary study of the data format problem and report the results at the next meeting.

15. Next meeting - December 2, 1960, 9:30 a.m. to 4:30 (Address)

ASA Headquarters
10 East 40th Street
New York City

NOTE: The shift in date occured as the result of the required attendance of the Chairman and Secretary at the O.E.M.I. Annual Meeting November 30, 1960 and December 1, 1960.

C. E. Macon

C. E. Macon
Secretary

X3-2 Sub-Committee
on
Character Sets & Data Formats
of the
American Standards Association
X3 Sectional Committee
Sponsored by
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MINUTES - APPENDIX A

ASSIGNMENTS

The following assignments have been made at the first and second regular meetings of the X3-2 Sub-Committee:

First meeting - October 4, 1960

1. E.I.A. study of 6 bit codes - Mr. Tholstrup
2. A chart, "6 Bit Codes vs Symbols" by R. W. Bemer on January 8, 1960 was issued. The following entries are to be confirmed by the member noted:

ENTRY	MEMBER
NCR 304	Mitter
704-709	Smith
BENDIX 1-0 TYPEWRITER	Macon
ALWAC III P TAPE	Schoenberg
HONEYWELL 1000	Reach
HONEYWELL 800	Reach
BENDIX G15 (CA-2)	Macon
PERSEUS	Macon
705	Smith
7070 TAPE	Smith
1401	Smith
650 TAPE	Smith
305 RAMAC	Smith
PHILCO 2000	Smith

ENTRY	MEMBER
DATATRON 220	Macon
DATATRON 205	Macon
1620 P TAPE	Smith
ALWAC III FLEXOWRITER	Schoenberg
HIDAC 101 P TAPE	Smith
USS 80	Bonn
UNIVAC	Bonn
BENDIX G15	Macon
LGP 30 FLEXO	Olofson
LINCOLNWRITER UC & LC	Emerson
RCA 501 - BIZMAC	Bonn
GAMMA 60	Smith
FERRANTI PROPOSAL	Macon
FIELDATA	Smith
MOBIDIC	Reach
STRETCH	Smith

Second Meeting - November [illegible], 1960

1. Revision of the chart, "6 Bit Codes vs Symbols."
    a. Using media as the independent variable.
    b. Using character array as the independent variable.

    Mr. Smith will investigate.

2. Obtain copies of the Grems-Mullery Report - ~~Mr. Bonn~~.
Mr. H.J. Smith.

---

3. Obtain copies of the Mackelroy Report on Foreign Alphabets - Mr. Tholstrup.

4. Detailed studies and reports
    a. Punctuation - Mr. Olofson
    b. Business - Mr. Bloom
    c. Math - Mr. Smith
    d. Engineering - Mr. Reach
    e. Science - Mr. Reach
    f. Circuit Diagrams - Mr. Smith and Mr. Macon
    g. Data Control - Mr. Schoenberg
    h. Machine Control - Mr. Schoenberg

5. Statement of Character Set Size and Contents from POL Committee (X3-4) - Mr. Bonn.

6. Preliminary study of the data format problem - Mr. Griffin.

C E Macon
C. E. Macon
Secretary

Schoenberg
Space
Move forward

X3-2 Sub-Committee
on
Character Sets & Data Formats
of the
American Standards Association
X3 Sectional Committee
Sponsored by
O.E.M.I.

November 15, 1960

NMAH 320/1

STATUS OF X3-2 ACTIVITIES
AS OF
NOVEMBER 11, 1960

1. Reference:
    a. Proposed Scope (Attached)
    b. List of Documents (Attached)
    c. List of Members (Attached)
    d. Assignments (Attached)

2. Meetings

Two meetings of the sub-committee have been held: the first October 4, 1960 and the second November 9, 1960. It has been decided that Task Groups will be identified at that point in the studies when they can be employed efficiently. For the next several regular meetings, X3-2 will sit as "committee of the whole."

The next meeting is scheduled for December 2, 1960.

3. Membership

A list of members is attached. The current committee consists of 14 members.

4. Scope, Objectives and Mode of Operation

These points have been examined at length by the sub-committee. The results of this examination are delineated in the attached "Proposed Scope."

5. Activities of the X3-2 Sub-Committee

In establishing itself as a working organization and persuing its objectives, the sub-committee has discussed and investigated the following points:

5.1 Frame of Reference

The sub-committee has studied the history and organization of the X3 Committee. In addition, it has studied the procedures and practices of Sectional Committees operating under the Constitution, By Laws and Procedures of the American Standards Association Incorporate.

The inter-relationships and inter-dependence of the X3 Sub-Committees has been examined at length. Plans for proper inter sub-committee liaison and communication have been initiated.

5.2 Technical Basis

There has been a great deal of work done in this area in the past. A number of documents have been issued to the members for study (see attached List of Documents). In addition, a number of organizations are working in this area and consideration has been given to ways and means of incorporating the results of their work in the sub-committee deliberations.

These activities are, of course, of a continuing nature.

5.3 Current Study

It has been established that identification of a basic character set is imperative as a "first step" in the studies to be completed. Accordingly, the sub-committee has started a detailed examination of the character set problem. Specific assignments have been made (refer to attached "Assignments"). It is anticipated that a basic character set can be tentatively identified at the next regular meeting. In accordance with the mode of operation, this set may have to be modified as the result of succeeding studies.

Basis for Report

This report has been derived from the Minutes and other documents pertaining to the sub-committee activities.

C E Macon
C. E. Macon

Secretary

X3-2 Sub-Committee

November 15, 1960

Character Data Formats

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X3-2 SUB-COMMITTEE MEMBERSHIP
AS OF
NOVEMBER 9, 1960

R. H. Allen
Product Planning Manager
Research Division
Moore Business Forms, Inc.
1001 Buffalo Avenue
Niagara Falls, New York
BUtler 5-9019

Voluntarily Resigned

L. Bloom
The National Cash Register Company
Electronics Division
1401 East El Segundo Boulevard
Hawthorne, California
PLymouth 7-1811

T. H. Bonn
Remington Rand UNIVAC
1900 West Allegheny Avenue
Philadelphia 29, Pennsylvania
BAldwin 3-0600

E. A. Emerson
Design Specialist
The National Cash Register Company
Electronics Division
1401 East El Segundo Boulevard
Hawthorne, California
PLymouth 7-1811

Replaced by L. Bloom

R. W. Green
Staff of the Vice President
Engineering and Research Division
The Standard Register Company
Dayton 1, Ohio

L. L. Griffin
Electronic Engineer
Navy Management Office
Department of the Navy
Washington 25, D.C.

H. Kleinberg
Manager, Computing Devices Engineering
Radio Corporation of America
Electronic Data Processing Division
Camden 2, New Jersey
WOodlawn 3-8000

I. C. Liggett — Chairman
IBM Corporation
590 Madison Avenue
New York 22, New York

C. E. Macon — Secretary
Engineering Project Section Manager
Burroughs Corporation
460 Sierra Madre Villa
Pasadena, California
SYcamore 3-6121

H. L. Marvin
Engineering and Research Division
The Standard Register Company — Voluntarily Resigned
Albany and Campbell Streets
Dayton 1, Ohio

T. S. Mitter
Product Planning Department
The National Cash Register Company — L. Bloom's Alternate
Dayton 9, Ohio
BA 6-1411

W. S. Nivison
Recordak Corporation
343 State Street
Rochester 4, New York

E. C. Olofson
Engineering Administration Manager
Royal McBee Corporation
1031 New Britain Avenue
West Hartford, Connecticut

R. W. Reach
Minneapolis-Honeywell Regulator Company
DATAmatic Division
151 Needham Street
Newton Highlands 61, Massachusetts
DEcatur 2-6960

L. J. Schoenberg
Monroe Calculating Machine Company
555 Mitchell Street
Orange, New Jersey

H. J. Smith
Corporate Logical Systems Standards
IBM Corporation
112 East Post Road
White Plains, New York
WHite Plains 9-1900

H. Tholstrup
Commercial Controls Corporation
Friden Incorporated
1 Leighton Avenue
Rochester 2, New York

B. B. Weber
Addressograph-Multigraph Corporation
1200 Babbit Road
Cleveland, Ohio

W. W. Zechel
Product Manager
UARCO Incorporated
300 West Congress Parkway — Voluntarily Resigned
Chicago 7, Illinois — Requested Minutes
HArrison 7-5141

O.E.M.I.
Data Processing Group
Room 2814, Graybar Building
420 Lexington Avenue
New York 17, New York

Capt. Luebbert, who was active in the Fieldata activities, has been invited to participate.

C E Macon

C. E. Macon
Secretary

Scope and Objectives

X3-2 Sub-Committee
on
Character Sets and Data Formats

Scope

? Recommendation to the X3 Sectional Committee of standards for the input and output media to data processing systems which is used for the interchange of information between such systems and between systems and associated equipment. Such recommended standards are to include:

1) The machine sensible coded character set

2) The detailed representations of that set for each media, i. e., as pertains to magnetic tape, punched cards, paper tape, etc.

wording 3) Such standard formats as are required to define data fields, data records, program instructions and the like.

Objective

? { To develop and submit a recommended standard, or set of standards, for each of the principal input/output media. To accomplish this objective, the following detailed objectives and mode of operation have been established:

Detailed Objectives:

1) Identify the basic character array, or arrays.

2) Establish the order of precedence for this array, or these arrays.

3) Determine the code set, or sets, which include this array or arrays.

? 4) Determine the logical format, or formats, required.

5) Identify the physical format and code representation of these coded character sets for each of the principal media.

? 6) Specify those physical parameters of each media required to permit its use as a vehicle for the interchange of information.

Mode of Operation:

The above objectives are quite interdependent, and, therefore, an iterative process will be employed, i. e., the first objective will be completed as far as possible at that time; the next will be pursued and so forth. When the last objective has been considered, attention will return to the first objective and the process continued until one more of the required standards can be drafted and recommended for X3 consideration. Attention will then return to the detailed objectives and the process continued until recommendations have been submitted and accepted on all required standards.

Note: The above has been derived from the sub-committee activities to date and will be submitted for sub-committee approval at the next regular meeting.

C. E. Macon
November 11, 1960

November 17, 1960

Mr. Smith

Please review and let me have your comments as soon as possible - like Friday. Please reply by phone. Thanks.

Vera Galetta
3226

X3-2 Sub-Committee
on
Character Sets & Data Formats
of the
American Standards Association
X3 Sectional Committee
Sponsored by
O.E.M.I.

December 2, 1960

MINUTES

#3 MEETING OF DECEMBER 2, 1960

Membership

MEMBERS

Present:

Leon Bloom - NCR

Theodore H. Bonn - Remington Rand

L. L. Griffin - Navy Department

I. C. Liggett - IBM

C. E. Macon - Burroughs Corporation

E. Clifford Olofson - Royal McBee Corp.

Roy W. Reach - Minneapolis Honeywell

Lawrence J. Schoenberg - Monroe Calculating Machine

H. J. Smith, Jr. - IBM

H. Spielman - RCA (Representing Mr. Kleinberg)

H. Tholstrup - Friden Incorporated

B. B. Weber - Addressograph-Multigraph Corp.

Not Present:

Robert W. Green - Standard Register Co.

H. Kleinberg - RCA

W. S. Nivison - Recordak

New:

John H. Craig - AT&T Co.

D. Hiz - Rem. Rand. Univac

Allen L. Whitman - Bell Telephone Laboratories

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2. Mr. Whitman stated that Teletype is attempting to lock-up on a six-bit code as soon as possible. He wishes to have this character set and code representation conform as closely as possible to any future ASA Standard.

3. Minutes - Corrections

3.1 Grems-Mullery report

It was noted that no assignment had been made to obtain copies of this report for the members. Mr. Smith was assigned this task.

3.2 Referring to paragraph 8.13.2 it was noted that the forthcoming "addendum" in fact, is to the Mil standard 188A and incorporates the Fieldata code as the standard for the Department of Defense.

4. Scope and Objectives

The scope and objectives were discussed in considerable detail and the results of this discussion were:

A. Summary revisions to the scope and objective statement - refer to the corrected revisions attached.

B. The Chairman is to write Mr. Virgil Gram, of EIA, requesting that organization to submit to X3-2 their recommendation for standards on the physical parameters for those media which they are investigating that are employed by data processing systems to interchange information.

5. Correspondence

Mr. Beek's letter was read to the membership and copies of his proposed standard referred to therein were distributed for studying.

6. Status

6.1 Mr. Tholstrup distributed copies of the McElroy report.

6.2 Mr. Bloom submitted a report entitled "Characters and Symbols Used in Business".

6.3 Mr. Reach distributed a paper entitled "Special Characters for Engineers and Science".

6.4 Mr. Bonn distributed a paper listing the character sets for CABOL & ALGOL as supplied from the problems oriented language committee.

6.5 Mr. Smith distributed a paper entitled "Desirable Symbols for Mathematics".

.6 Mr. Smith submitted a paper entitled "Analysis of Chart Six-Bit Codes Versus Symbols".

6.7 Mr. Bloom submitted a chart of character sets for codes for the National Cash Register Equipment.

6.8 Mr. Macon submitted a report for Bendix Computer Division, entitled "G-15 and G-20 Character Codes".

.6.9 Mr. Olofson presented a verbal report on "Punctuation" to be considered. He will document this report and supply copies to the members.

6.10 Mr. Schoenberg presented a verbal report on "Symbols Which Would Be Included for Data Control and Machine Control". Mr. Schoenberg will document this report and supply copies to the members.

7. Future Meetings

7.1 It was decided that monthly meetings are required.

7.2 The possibility of holding the February meeting in California and expanding it to a two or three day session was discussed. The members are to consider this possibility and the matter will be discussed and decided at the next meeting.

7.3 Next meeting

The next meeting will be held January 11th, and 12th 1961 from 9:30 AM to 4:30 PM.

ASA Headquarters
10 East 40th Street
New York City, N. Y.

C E Macon
C. E. Macon
Secretary

3-2 Sub-Committee
on
cter Sets & Data Formats
of the
ican Standards Association
X3 Sectional Committee
Sponsored by
O.E.M.I.

November 15, 1960
Revised Dec. 2, 1960

SCOPE AND OBJECTIVES

SCOPE

Recommendation to the X3 Sectional Committee of Standards for coded character sets and recording formats for the interchange of information between Data Processing systems and between systems and associated equipment. Such recommended standards are to include:

1. The machine sensible coded character set.
2. The detailed representation of that set and the delineation of the physical parameter for each medium ~~media~~ (i.e., as pertains to magnetic tape, punched cards, paper tape, etc.).
3. Such standard formats and format indicators as are required to define data fields, data records, program instructions and the like.

OBJECTIVES

To develop and submit a recommended standard, or set of standards, for each of the principal input/output media. To accomplish this objective the following detailed objectives and mode of operation have been established.

Detailed Objectives:

1. Identify the basic character arrays.
2. Establish the order of precedence for each array.
3. In each case determine the code set which includes the array.
4. Determine the logical formats or format indicators required.
5. Integrate provisions for orderly expansion of these coded character sets.

6. Identify the physical format and code representation of those coded character sets for each of the principal media.

7. Specify those physical parameters of each ~~media~~ medium required to permit its use as a vehicle for the interchange of information.

MODE OF OPERATION

The above objectives are quite interdependent and therefore an iterative process will be employed. That is, the first objective will be completed as far as possible at time of consideration; the next will be pursued; and so forth. When the last objective has been considered, attention will return to the first objective and the process continued until one or more of the required standards can be drafted and recommended for X3 consideration. Attention will then return to the detailed objectives and the process continued until recommendations have been submitted and accepted on all required standards.

> NOTE: The above has been derived from the sub-committee activities to date and will be submitted for sub-committee approval at the next regular meeting.

C E Macon

C. E. Macon
Secretary

December 1, 1960

Agenda for December 2 Meeting of X3-2 Subcommittee on Character Sets and Data Format

1. Opening Remarks
1.1 Introduction of any new members
1.2 Review of minutes of last meeting

2. Reports on previous assignments
2.1 "Confirmation of entries to 6 bit code versus symbols"
2.2 Report on alternative formats
2.3 Greins-Mullery report
2.4 MackElroy report
2.5 Detailed studies and reports on character subsets
2.6 Report on POL Committee requirements
2.7 Data format

3. Other business

4. Scheduling of next meeting

5. Closing remarks.

December 7, 1960

Memorandum To File

Subject: X3-2 Meeting - December 2, 1960

Discussed and altered some wording of our scope. Our responsibilities include physical standards as well as logical standards. We are requesting EIA to recommend physical standards.

Messrs. Craig and Whitman from ATT and Bell Labs respectively were present. They stated that ATT had recently spoken with the Fieldata people in an attempt to establish a 6 bit code for teletype. ATT has made the commitment to extend the present teletype equipment to handle 6 bit code study instead of Baudot. In talking with the Fieldata people they reversed their position concerning M/N or fixed weight codes and have agreed to use a code more suitable to data processing such as the Fieldata code or something similar. This could be the X3-2 code if we work fast enough.

Presentations were made by each member concerning characters for the basic character set. Status is as follows: We are in agreement on the Arabic numerals, the alphabet A-Z, and the blank. A survey of existing codes used on present equipment indicated probable use of 10 punctuation characters and 8 business symbols. This adds to a total of 55.

Mr. L. J. Schoenberg of Monroe discussed machine control and data control symbols and stated he needed about 4-5. I think this may be low. The data transmission people (Whitman) want several characters for transmission reasons. A proposal between ATT and Fieldata includes the basic typewriter with capital letters only and most of the special characters on the keyboard typewriter, adding to 63-64. This set of characters (Whitman) and our proposed set, based on current DP equipment, are not too far apart. Mr. Whitman is supposed to send us a copy of the typewriter keyboard and the 63-64 character set being proposed.

NMAH

3/6/1

Mr. H. J. Smith is preparing a comparison of our IBM proposed (internal only) character set and the X3-2 tentative set. This should be compared with the Whitman set and some conclusion reached.

Messrs. Craig and Whitman emphasized the need for some fast action as they want to move ahead on the 6 bit equipment.

I. C. Liggett

ICL:vmg

cc: ISS Group Members

Mr. B. L. Havens
Mr. H. J. Smith
Mr. F. A. Williams

NW AH 310/1

December 7, 1960

Memorandum To File

Subject: X3-2 Meeting - December 2, 1960

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I. C. Liggett

ICL:vmg

cc: ISS Group Members

Mr. B. L. Havens
Mr. H. J. Smith
Mr. F. A. Williams

NMAH 320/1

Proposed 6-Unit Code for Teletypewriter and Other Data Communications to Operate with 4-Row Electric Typewriter Keyboard - Files 37729, 37766-7, and 39065

December 19, 1960

ABSTRACT

A 6-unit code for teletypewriter and other data communications is proposed to give monocase (all capital letters) operation with a 4-row keyboard format similar to that of the standard electric typewriter. This proposal, compiled from the work of others, is one of several being considered. Its presentation here is intended to aid negotiations toward the goal of a common plan which might be used for both data operation over teletypewriter circuits and also for data operations with computers without the need for converters or translating devices.

MEMORANDUM FOR FILE

This memorandum presents, as a collation of the work of others, one of several proposals for a 6-unit code to work with a format closely similar to that of a standard 4-row electric typewriter keyboard. It is intended to provide first for monocase operation (all capital letters) but also to be compatible with the future possible use of an UP-LO (upper and lower case letters) format of the same general kind. It is presented at this time primarily as a basis for negotiation in the hope that agreement might be reached on a common code both for data operation over teletypewriter circuits and also into computers without the need for converting or translating devices.

Preliminary exploration shows that this is not an impossible ideal, but that it will require some compromises. This memorandum will not attempt to suggest what those compromises might be.

Hopefully in the interest of clarity, the proposals in this memorandum are presented positively without, in general, indications of alternatives. It should be understood, however, that nothing herein is necessarily final and that any statements made are open to change during negotiating processes. This does not record any management decisions as to choice of codes.

Basic Premises

The following are the basic premises on which the proposal depends:

1. The characters in the format, with a few exceptions, are those of the standard electric typewriter keyboard, as shown in Fig. 1 and on Table 3, attached.
2. Where lower and upper symbols appear on the same keytop, the code for the upper symbol is the same as that for the lower symbol with the addition or deletion of one code element. The upper symbol code is generated by the simultaneous depression of the SHIFT key (see Fig. 1) and the key containing the desired symbol. (In the particular example of this memorandum, this operation deletes the No. 4 teletypewriter code element; see Table 1 and Fig. 1 for the relationships.)
3. The codes UC and LC (for the upper and lower case shift operations) are reserved for possible future UP-LO operation.
4. The character with all 6 information bits marking will not be used, as in the present-day Baudot code, for LTRS shift, but only as a RUBOUT, "Delete", or "Idle" character.

Code Proposal

The details of the proposed code are shown on Table 1, together with the associated consecutive progression of binary numbers, here, however, written in mirror-image or inverse order with the least significant digit on the left instead of on the right. This is so that the data code element numbering, in the adjoining columns, will correspond with the Fieldata code now being standardized by the U.S. Army Signal Corps.

Table 1 also shows, for convenient reference, the decimal equivalents of the binary numbers.

The keytop decimal numerals may be seen to be equivalent to binary numbers given, in inverse order, by the four left-hand digits of the binary code.

Correspondence with the Fieldata Code of the U.S. Army Signal Corps

Table 2 shows side by side, for comparison, the symbols of the Fieldata code and of the proposal of this memorandum. These are the same with the exception of a few punctuation marks, the upper symbols for Bell and WRU (who are you), and the names of the functions Blank (Master Space), Stunt (Special), and Rubout (Idle).

Correspondence with EIA Proposals

The current EIA proposals are given in a report entitled "Tentative Standards Proposal, Basic Character Set Code", dated May 25, 1960. This report represents the combined action of the TR-24.4.1 and TR-24.4.3 Subcommittees on Language and Format for Punched Tape and Magnetic Tapes, respectively.

That report is limited to proposals for the alphabet letters and the decimal numerals; it does not list any punctuation or control characters.

The proposal of the present memorandum is the same, for the letters and numerals, as Code C of the EIA report. The report states that "Code A was selected.....for this tentative standard". This indicates an area where negotiation is called for if a single standard is to result.

Lower to Upper Symbol Transformation

Where lower and upper symbols appear on the same keytop, the upper symbol is generated by the simultaneous depression of the SHIFT key (See Fig. 1) and the key containing the desired symbol. Table 3 shows the relation of upper and lower symbols as on Fig. 1. Examination of the corresponding codes on Table 1 will show that in every case the codes for the lower and upper symbols are alike except that, for the upper symbol, code element No. 4 is deleted. The operation of the SHIFT key performs this deletion.

Keys not having an upper symbol could be locked or otherwise disabled when the SHIFT key is depressed, to prevent the generation of a false character.

As Table 3 shows, there are four punctuation and control characters which appear on single-character keytops, the comma, the period, STUNT and RUBOUT. The term STUNT means the same as "Escape", sometimes used to mean an "escape" into another code set. For example, the STUNT followed by a letter T might be used to perform a tabulate function.

Changes from Standard Electric Typewriter Keyboard

The following are noted as exceptions to the standard electric typewriter keyboard format:

1. Above the numeral 2, BELL is used instead of @
2. Above the numeral 6, WRU is used instead of ¢
3. The Backspace key is omitted
4. Additional keys for Data Operation
    a. Carriage Return (CR)
    b. Line Feed (LF)
    c. STUNT
    d. RUBOUT

Possible Optional Type Arrangements

The desirable objective for a new data code is a single common code which will suit the needs of all users.

If, however, basic differences develop during negotiations, consideration might be given to standardizing two or more different arrangements. Experience with the present-day four different standard type arrangements for the Baudot code as used with teletypewriters supports the practicability of such a variety of choices.

There would be a considerable advantage here if, as in the Baudot case, the differences were confined to the punctuation and the control symbols. It is more important to reach a common agreement for the codes associated with the alphabet letters and the numerals.

With such a plan, conversion of a keyboard, for instance, would involve nothing but a change of keytops to show the differences in symbols. Printers could be changed by simple changes of type pallets or type wheels. Other more complicated changes might be needed in the case of control characters, depending on what the control function was and how it was activated.

Character Printing

On a page printer, the function characters will normally not either print or space. (The Space character itself will cause spacing.) On a monitoring printer (usually a tape printer) all characters will print. Suggested symbols, based mostly on current practice with the Baudot code, are as follows:

	Symbol
Blank	ll
Upper Case (UC)	⩚
Lower Case (LC)	⩛
LINE FEED (LF)	≡
Carriage Return (CR)	<
Space	▬
Bell	Bell-shaped symbol
WRU	Maltese cross
Stunt	(not assigned)
Rubout	(not assigned)

Use of 7- and 8-Bit Codes

Nothing in this study should be taken to mean that the possible future use of 7- or 8-bit codes is excluded. It is simply that they have not been included in the plan here discussed.

It is recognized that the Army's Fieldata code in its complete form contains a 7th bit, as an information bit, and 8th bit as a parity bit.

Allen L. Whitman
ALLEN L. WHITMAN

NY-3111-ALW-CS

Att.
Tables 1, 2 and 3
Fig. 1

Copies to
(See next page)

GN-552-2 (12-55)

Table 1

Preliminary Proposal for 6-Unit Code for Teletypewriter and Other Data Communications Based on Modified Fieldata Code and EIA Plan C

Table 1

	Binary Code *		Data Code Elements		Letter or Function	Decimal No.	Binary Code *		Data Code Elements		Symbol Lo	Symbol UP	
0	0000	00	---	---	Blank	32		01	---	--5		)	
1	1000		0		UC	33	1000		0	5		!	
2	0100		1		LC	34	0100		1	5	Note	Bell	
3	1100		01		LF	35	1100		01	5	1	#	
4	0010		2		CR	36	0010		2	5		$	
5	1010		0 2		Sp	37	1010		0 2	5		%	
6	0110		12		A	38	0110		12	5		WRU	Note 2
7	1110		012		B	39	1110		012	5		&	
8	0001		---	3	C	40	0001		---	3 5		*	
9	1001		0	3	D	41	1001		0	3 5		(	
10	0101		1	3	E	42	0101		1	3 5		"	
11	1101		01	3	F	43	1101		01	3 5		:	
12	0011		2	3	G	44	0011		2	3 5		?	
13	1011		0 2	3	H	45	1011		0 2	3 5		—	
14	0111		12	3	I	46	0111		12	3 5	,		
15	1111		012	3	J	47	1111		012	3 5	.		
16	0000	10	---	-4-	K	48	0000	11	---	-45	Ø		
17	1000		0	4	L	49	1000		0	45	1		
18	0100		1	4	M	50	0100		1	45	2		
19	1100		01	4	N	51	1100		01	45	3		
20	0010		2	4	O	52	0010		2	45	4		
21	1010		0 2	4	P	53	1010		0 2	45	5 ←		
22	0110		12	4	Q	54	0110		12	45	6		
23	1110		012	4	R	55	1110		012	45	7		
24	0001		---	34	S	56	0001		---	345	8		
25	1001		0	34	T	57	1001		0	345	9		
26	0101		1	34	U	58	0101		1	345	'		
27	1101		01	34	V	59	1101		01	345	;		
28	0011		2	34	W	60	0011		2	345	/		
29	1011		0 2	34	X	61	1011		0 2	345	-		
30	0111		12	34	Y	62	0111		12	345	Start		
31	1111		012	34	Z	63	1111		012	345	Rubout		

* As written here this is the "reflected" or "mirror image" binary code with the least significant digit on the left instead of on the right.

Notes:
1. Shift key when held down deletes No. 4 pulse for cases where UP symbol is shown; see Table 3
2. WRU = Who Are You? - to trigger answerback from remote called station

ALW DEC 20 1960

TABLE 2

Proposals for 6-Unit Data Code Characters

1. Fieldata Versus 2. Proposal of This Memo

Decimal No. (Note 1)	Character		Decimal No.	Character	
	Fieldata	This Memo		Fieldata	This Memo
0	Master Space	Blank	32	)	)
1	UC	UC	33	-	!
2	LC	LC	34	+	Bell
3	LF	LF	35	<	#
4	CR	CR	36	≠	$
5	Sp.	Sp.	37	>	%
6	A	A	38	=	WRU (Note 2)
7	B	B	39	$	&
8	C	C	40	*	*
9	D	D	41	(	(
10	E	E	42	"	"
11	F	F	43	:	:
12	G	G	44	?	?
13	H	H	45	!	—
14	I	I	46	,	,
15	J	J	47	⊕	.
16	K	K	48	0	0
17	L	L	49	1	1
18	M	M	50	2	2
19	N	N	51	3	3
20	O	O	52	4	4
21	P	P	53	5	5
22	Q	Q	54	6	6
23	R	R	55	7	7
24	S	S	56	8	8
25	T	T	57	9	9
26	U	U	58	'	'
27	V	V	59	;	;
28	W	W	60	/	/
29	X	X	61	.	—
30	Y	Y	62	Special	Stunt
31	Z	Z	63	Idle	Rubout

Notes:

1. This is the decimal equivalent of the binary number for the code. See Table 1.

2. WRU = Who Are You? to trigger answerback from remote called station.

ALW
12/5/60

TABLE 3

Relation of Lower and Upper Keytop Symbols on Electric Typewriter (Note 3)

Lower Symbol		Upper Symbol	
Decimal No.	Char.	Decimal No.	Char.
48	0	32	)
49	1	33	!
50	2	34	Bell
51	3	35	#
52	4	36	$
53	5	37	%
54	6	38	WRU (Note 2)
55	7	39	&
56	8	40	*
57	9	41	(
58	'	42	"
59	:	43	:
60	/	44	?
61	—	45	—

See Note 1

Single Character Keytops

46	,
47	.
62	Stunt
63	Rubout

Notes:

1. Codes for upper symbols are lower symbol codes with No. 4 bit deleted; hold down SHIFT key for upper symbol. Note constant difference of 16 between decimal equivalents of binary numbers.

2. WRU = Who Are You?

3. Fig. 1 shows the electric typewriter keytop arrangement with added data control keys.

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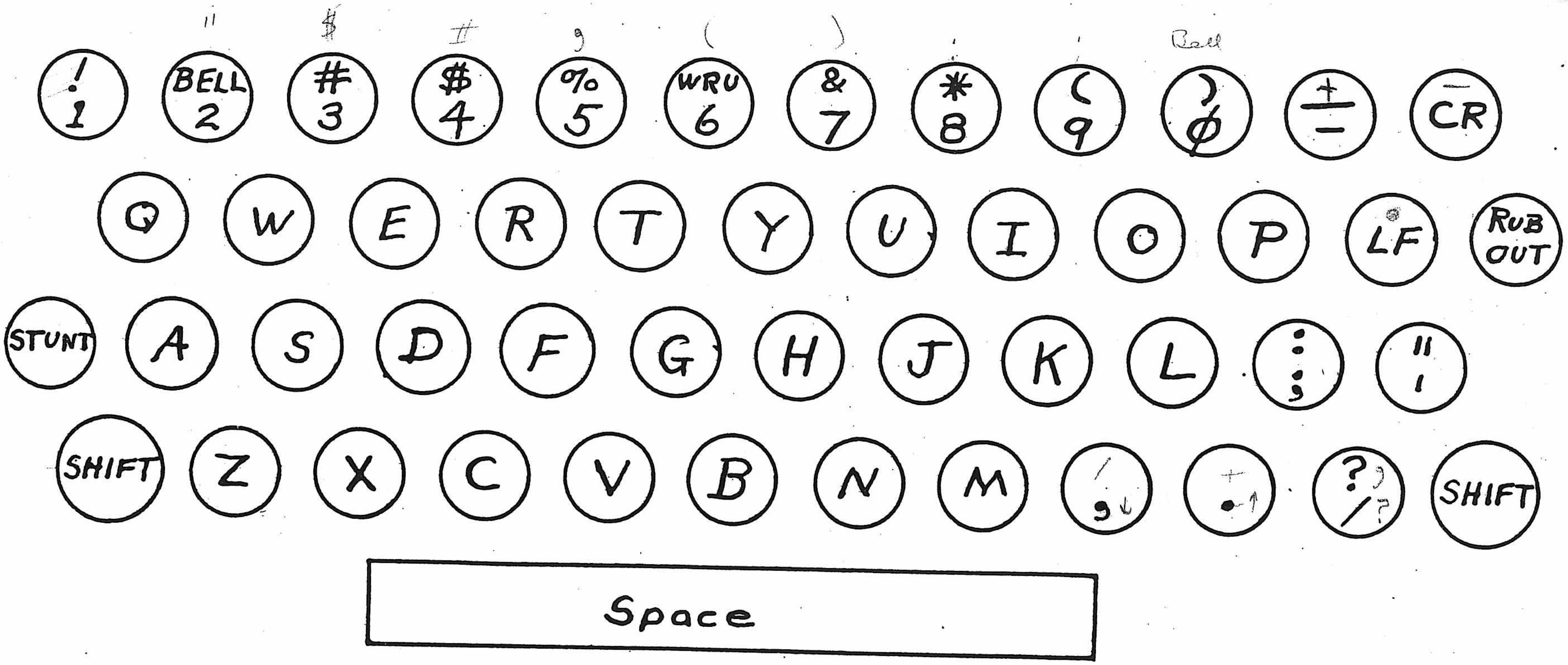
12/5/60



Keyboard Format Based on
ELECTRIC TYPEWRITER FORMAT
To Go with 6-Unit Code

Fig. 1

Fig. 1

December 27, 1960

MR. IRVING C. LIGGETT
Director of Systems Standards
International Business Machines Corporation
590 Madison Avenue
New York, New York

Dear Mr. Liggett:

Mr. A. L. Whitman of the Bell Telephone Laboratories told me of his conversation with you concerning the activities of the X3-2 Committee on Coded Character Sets and Standard Data Format. I also had the pleasure of listening to Mr. John Howard outlining the activities of the OEMI in this and related areas.

Teletype Corporation is, as I am sure you know, a large manufacturer of record communications equipment. While this activity has been primarily in 5 and 6 level language, we have within the past several years been expanding our activity in higher level equipments and expect to continue to participate significantly in data and message communications employing codes of all levels. We are currently working with the Bell System, Western Union Telegraph and the military on code language questions with a view toward standardizing communications languages where possible. Because of this activity and its close relation to the work you are doing I should like to represent the Teletype Corporation in the activities of your subcommittee, either as an observer or as an active member.

We feel that the Teletype Corporation's stake in this matter is high and of course would be willing to contribute effort toward making your program go. In my present position as Director of Product Development I am responsible for coordination of these matters within Teletype Corporation and would expect to personally take an active part in your efforts, should you be so kind as to let me join your group.

I understand that the next meeting of the group is January 11, 1961 and that my attendance would be welcome. I plan to be there on that day and look forward to meeting you.

Yours very truly

ORIGINAL SIGNED BY
J. E. AUWAERTER

Director of Product Development

NMAH 3/8/1

JFA:AC

Copy to:
Mr. W. J. Zenner - 10, Mr. D. R. Carmichael - 30, Mr. R. H. Klich 9100

PHONE CORNELIA 7-6700
TWX NO. SKO. 3454

TELETYPE CORPORATION

5555 TOUHY AVENUE
Skokie, Illinois

December 30, 1960

J. F. AUWAERTER
Director of Product Development

MR. J. H. CRAIG, Private Line and TWX Engineer
American Telephone and Telegraph Company
195 Broadway
New York 7, New York

Dear Mr. Craig:

At our meeting in your office November 29, we agreed on a 6 level code alphabet for use in the proposed 4-row keyboard, mechanized TWX service. The code alphabet and the resultant keyboard arrangement are contained in the attachments.

Tooling of the Model 30 and Model 28 apparatus for the new service is proceeding in accordance with these agreements. The line signal will contain a 1.0 unit start pulse, six intelligence bits of unit length, and a 1.5 unit stop pulse. It will be transmitted in 0 thru 5 bit order at 85 bauds to provide 100 word per minute operation.

You know, of course, that the code alphabet being adopted is quite similar to the Fieldata code except where deviations are required to provide a typewriter keyboard arrangement. As discussed with you and Mr. Young, we are informing the Military Communication System Technical Standards Committee of our agreement on the new alphabet and are suggesting that they modify the symbol assignments of the Fieldata language to achieve compatibility with our new commercial standard.

Yours very truly

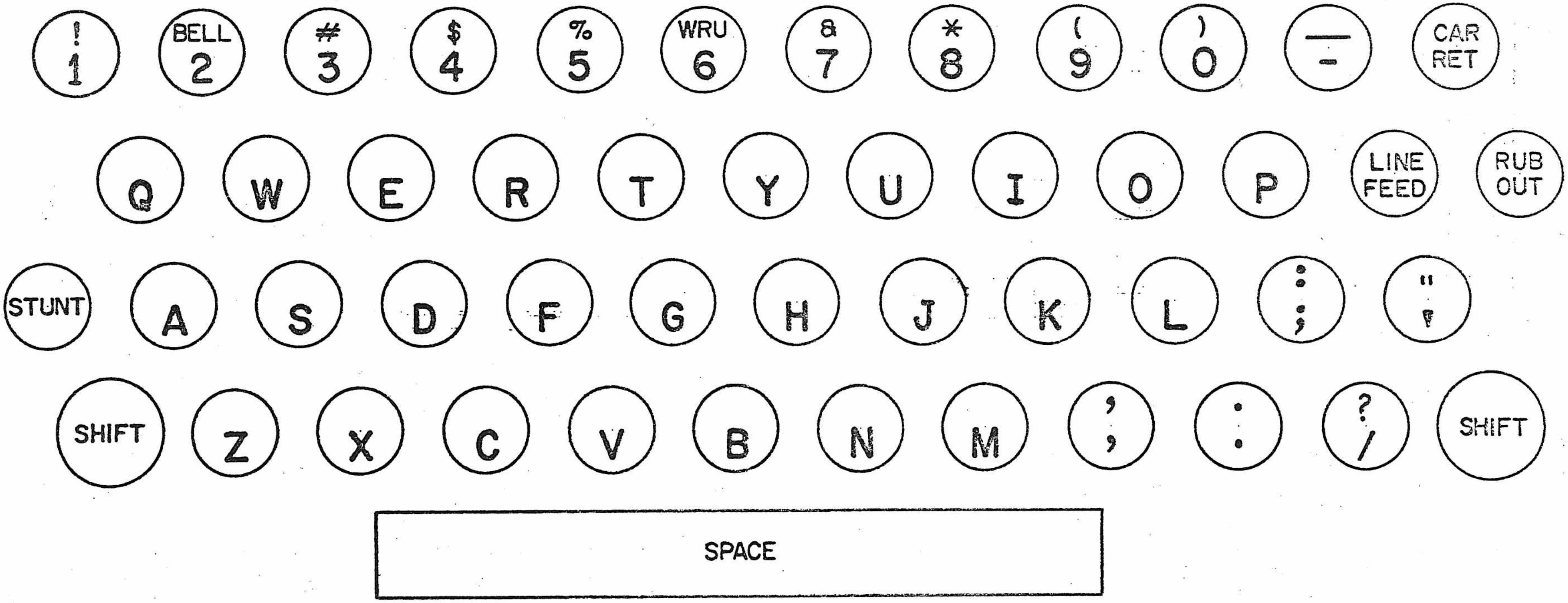
John Auwaerter
Director of Product Development

JFA:AC

Enc.

Copy to:
Mr. W. Y. Lang - BTL
Mr. A. L. Whitman - BTL
Mr. V. M. Wolontis - BTL
Mr. W. R. Young - BTL
Mr. J. B. Booth - AT&T

NMAH 310/1



TYPEWRITER KEYBOARD FORMAT FOR TELETYPEWRITER USE

NOTES

1. SHIFT KEY DELETES BIT NO.4 WHEN DEPRESSED.
2. WRU KEY GENERATES "REQUEST FOR ANSWER BACK" OR "WHO ARE YOU" SIGNAL.
3. STUNT KEY CAUSES SUCCEEDING CHARACTER TO PERFORM A NON-PRINTING FUNCTION.

11-29-60

November 29, 1960

6-BIT COMMUNICATION CODE

CHANNEL 0 1 2 3 4 5		CHANNEL 0 1 2 3 4 5	
0 0 0 0 0 0	Blank	0 0 0 0 0 1	)
1 0 0 0 0 0	U.C.	1 0 0 0 0 1	!
0 1 0 0 0 0	L.C.	0 1 0 0 0 1	Bell
1 1 0 0 0 0	LF	1 1 0 0 0 1	#
0 0 1 0 0 0	CR	0 0 1 0 0 1	$
1 0 1 0 0 0	Space	1 0 1 0 0 1	%
0 1 1 0 0 0	A	0 1 1 0 0 1	WRU
1 1 1 0 0 0	B	1 1 1 0 0 1	&
0 0 0 1 0 0	C	0 0 0 1 0 1	*
1 0 0 1 0 0	D	1 0 0 1 0 1	(
0 1 0 1 0 0	E	0 1 0 1 0 1	"
1 1 0 1 0 0	F	1 1 0 1 0 1	:
0 0 1 1 0 0	G	0 0 1 1 0 1	?
1 0 1 1 0 0	H	1 0 1 1 0 1	_
0 1 1 1 0 0	I	0 1 1 1 0 1	,
1 1 1 1 0 0	J	1 1 1 1 0 1	.
0 0 0 0 1 0	K	0 0 0 0 1 1	0
1 0 0 0 1 0	L	1 0 0 0 1 1	1
0 1 0 0 1 0	M	0 1 0 0 1 1	2
1 1 0 0 1 0	N	1 1 0 0 1 1	3
0 0 1 0 1 0	O	0 0 1 0 1 1	4
1 0 1 0 1 0	P	1 0 1 0 1 1	5
0 1 1 0 1 0	Q	0 1 1 0 1 1	6
1 1 1 0 1 0	R	1 1 1 0 1 1	7
0 0 0 1 1 0	S	0 0 0 1 1 1	8
1 0 0 1 1 0	T	1 0 0 1 1 1	9
0 1 0 1 1 0	U	0 1 0 1 1 1	'
1 1 0 1 1 0	V	1 1 0 1 1 1	;
0 0 1 1 1 0	W	0 0 1 1 1 1	/
1 0 1 1 1 0	X	1 0 1 1 1 1	-
0 1 1 1 1 0	Y	0 1 1 1 1 1	Stunt
1 1 1 1 1 0	Z	1 1 1 1 1 1	Rub-Out

Survey of Coded Character Representation

R. W. Bemer, *IBM Corp., White Plains, N. Y.*

Technical Committee 97 of the International Standards Organization (ISO) is concerned with standards in data processing. The American Standards Association holds the secretariat of this committee. Sectional Committee X3 of A.S.A. is responsible for national data processing standards in the U. S.

One of the most important areas of standardization (and one of the most pressing) is that of the logical representation of the character sets. These representations may be by punched holes in paper tape, pulses on a communications line, bits stored in memory, marks on paper, etc. The existing standards work in this area has been done by MEE 149 (now DPE) of the British Standards Institution and by TR 24.4 (now TR 27.6) of the Electronic Industries Association. This particular problem is now under the cognizance of A.S.A. Sub-committee X3.2 on character sets and data format.

The chart (pp. 640–1) is presented as staff work for the deliberations of X3.2. It is the most complete information we have been able to assemble to date, but obviously there may be errors and omissions. The primary aims in publishing this chart are:

(1) To indicate to the information processing industry why standardization is vital in this area.

(2) To request further information from the various experts who possess it.

The chart is presented in 64-character modules (sufficient for a 6-bit set) and the positions are given designations in the octal number system from 00 to 77. For the benefit of anyone not familiar with this notation, a conversion table is given:

Octal	Binary
0	000
1	001
2	010
3	011
4	100
5	101
6	110
7	111

"1" represents an ON or a punched hole condition. "0" represents OFF or an unpunched condition. Obviously, the conversion between physical and logical representation may be made in two ways (for example, depending upon which edge of the paper tape is on your right hand).

Five-track paper tape is shown as though one of either the letter or figure shifts had a sixth track. In most cases this is theoretical. The letter shift-figure shift relationship is indicated on the chart together with the tape orientation. If a "3" appears in the column marked units, then the "3" hole side is octal 01. If a "2" appears in the units column the reverse is true. In most British tapes the letter shift is shown in the high position because the collating sequence adopted by the British for six-track codes puts the digits low to the alphabet. The converse is mostly true in the U. S.

Note: The 704 and 705 codes, for example, apparently violate this statement since the digits have lower octal representations than the alphabet. *However*, ordering of files is controlled by a collating sequence in which the digits are higher than the alphabet. This is accomplished either by a comparison matrix in hardware or by programmed replacement of the keys in the records to be ordered.

Some seven element codes are shown on two lines. In most cases these are accomplished by an upper and lower case shift on the input key board. These cases are indicated. The 7030 actually uses the seven (and eight) bit set internally.

The elements of the code sets may possess either informational or control characteristics. In my personal opinion they should not possess both. Informational characters are shown by their single graphics. Control and functional characters are coded with two-letter mnemonics according to the following table, except for blank (which is shown as a lower case *b* with a slash through the stem) and special (Ⓢ).

BK—black
BL—bell
BS—backspace
CL—clear
CM—card mark
CO—compute
CR—carriage return
CS—carriage shift
DL—delete (erase)
EB—end block
ED—end data
EF—end file
EI—end information
EN—end number
ER—error
ES—escape
FF—form feed (paper throw)
FS—figure shift
ID—idle
LC—lower case
LF—line feed
LS—letter shift
MS—master space
NA—no action
NL—new line (CR + LF)
NP—non-print
OP—optional
PA—put away
PC—page change
PF—punch-off
PO—punch-on
PR—print restore
RD—red
RE—read
SI—shift in
SK—skip
SM—segment mark
SO—shift out
SP—space
ST—stop
TB—tabulate
TF—tape feed
TM—tape mark
UC—upper case
WA—who are you?

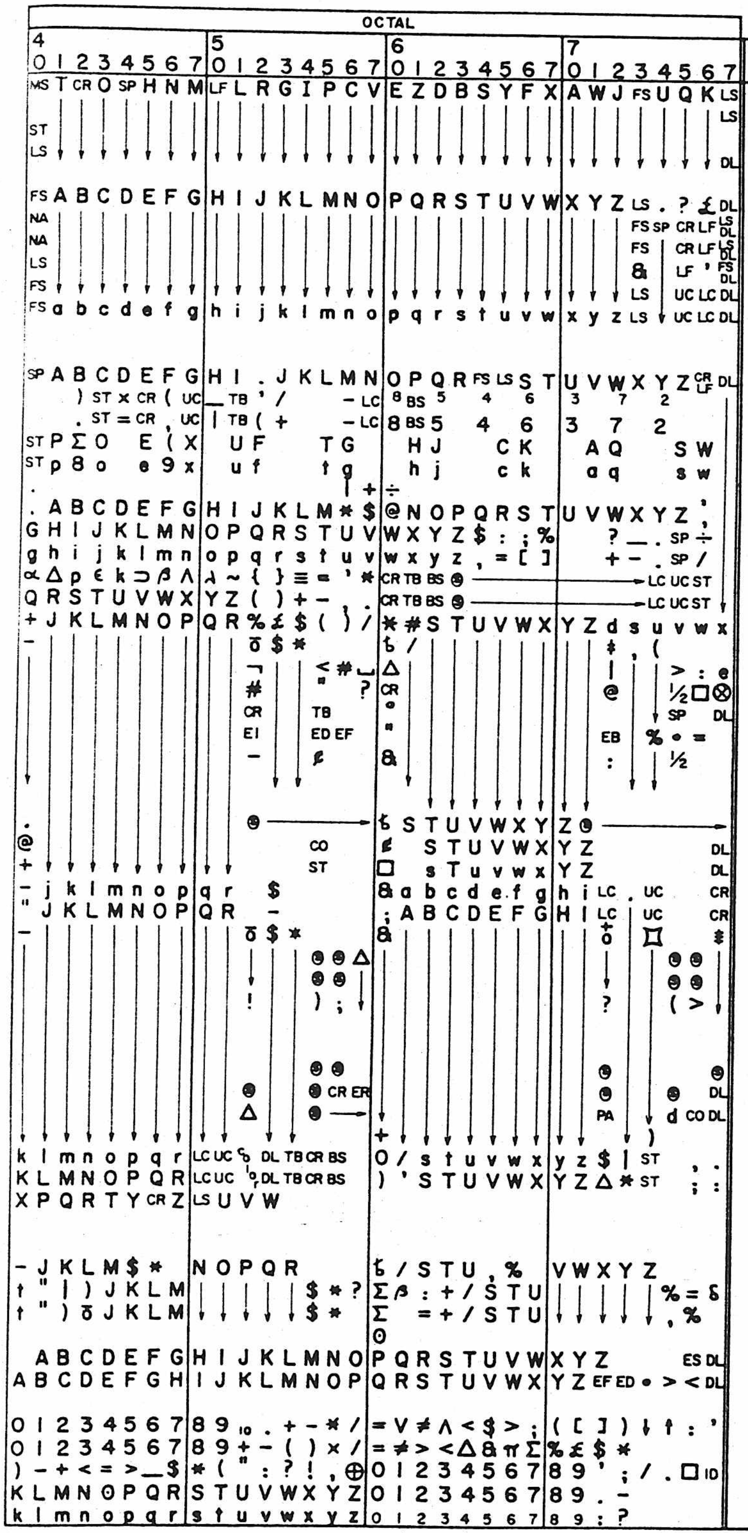
v3#12 Dec 1960

Survey of Coded Character Representation

MACHINE	CASE	OCTAL 0	1	2	3
		0 1 2 3 4 5 6 7	0 1 2 3 4 5 6 7	0 1 2 3 4 5 6 7	0 1 2 3 4 5 6 7
C.C.I.T.T.		NA 5 CR 9 SP OP , .	LF) 4 OP 8 0 : ;	3 " WA ? BL 6 OP /	- 2 ' FS 7 1 (LS
TELETYPE		#	& : ;	" $? BL ! /	' (
FLEXOWRITER		↓ ↓ ↓ ↓ (↓ ↓	↓ & ↓ ↓ NP PF	↓ PO1 TB $ / ↓ , PO2	↓ ↓ ER ↓ ↓ PR
METRO-VICK 950		LS ? ↓ + ↓ £ ↓ ↓	↓ ↓ * @ % - =	0 1 2 3 4 5 6 7	8 9 ↓ ! / (DL
LEO		— EN EB		1 2 4 7	8 10 11
PEGASUS - MERCURY		FS 1 2 * 4 ( ) 7	8 ≠ = - ∨ LF SP ,	> ≧ → /	x + LS . n CR
ELLIOTT 405		ƀ * $ =	! , +" : - . %	( ) ? /	£10 FS SP CR LF LS
B.S.I. DRAFT - MAY '59		NA	+ ‖	WA	10 FS CR LF LS DL
E.M.I. 1100, 2400		LS ↓ ↓) ↓ ½ % ↓	↓ £ + ‖ / ↓ ↓ NA	↓ → (↓ ⅓ ↓ ↓ *	¼ ↓ 10 ¾ LF X FS DL
PEGASUS FLEXOWRITER	UPPER	FS ¼ ½ SW / PR NP <	> ' CR ; TB NL ,	£ PO PF ¾ RD & ? BS	ST % = LS UC LC DL
" "	LOWER	FS 1 2 SW 4 PR NP 7	8 + - ‖ TB NL .	0 PO PF 3 BK 5 6 BS	ST 9 10 LS ↓ UC LC DL
STANTEC ZEBRA		0 3 5 6	9 K Q . L R I	B C D E T U V N	A X + - Y Z P #
E.M.I. M/C TOOL			S T U V ƀ CR LF	ST B C D E F G H	J K L M N A R DL
ENGLISH ELEC. DEUCE		↓ ↓ ↓ ↓ ↓ ↓ ↓ ↓	↓ ↓ 10 11 12 13 14 15	16 17 18 19 FS LS	+ - . EN SP CR LF DL
1103A TYPEWRITER	UPPER	T δ O ƀ H N M	L R G I P C V	E Z D B S Y F X	A W J 9 U Q K O
" "	LOWER	↑ °r o ƀ h n m	l r g i p c v	e z d b s y f x	a w j 9 u q k O
LGP-30 FLEXOWRITER	UPPER	RE Z) ƀ LC B L _	UC Y * = °c R " :	CR I Δ ? BS D %]	TB N $ [M π V
" "	LOWER	RE z 0 ƀ LC b l -	UC y 2 + °r r 3 ,	CR i 4 / d 5 .	TB n 6 , m 7 v
RPC - 9000	UPPER	ƀ LF ST) ° " # =	£ ¢ & (☻ TB _	☻ → UC LC ?	: ☻ °c ☻ →
"	LOWER	LF ST 0 1 2 3 4	5 6 7 8 9 ☻ TB -	☻ → ↓ UC LC /	; ☻ °r ☻ → %
RPC - 4000	UPPER	CR TB BS °c UC LC LF	ST	) ° " # Σ Δ @ &	' (A B C D E F
"	LOWER	↓ CR TB BS °r UC LC LF	ST	0 1 2 3 4 5 6 7	8 9 a b c d e f
LINCOLNWRITER	UPPER	☞ Σ | ‖ / × # →	< > ¯ □ ☻ →	m ⊂ ∨ q ϒ ţ w x	i y z ? ∪ ∩ j k
"	LOWER	0 1 2 3 4 5 6 7	8 9 _ ○ ☻ →	A B C D E F G H	I J K L M N O P
NCR - 304			@ ¢ ƀ & . ,	- A B C D E F G	H I □ Δ m n o p
704, 709, 7090			= '	+	ŏ .)
PHILCO 2000			@ ; ≡ & '		n % ?
M-H 800			' : ƀ ¢ &		; % ■ Δ
BENDIX I/O TYPER			↓	↓	> ; Λ
RCA 301			_ # @ ( )	&	+ ; "
M-H 1000			' ↓ ↓ +	ƀ	CR ( )
ALWAC III (CARD)		ƀ		&	↓ □
BENDIX G 15 (CA-2)		ƀ			
PERSEUS		0	10 11 12 ☻ →	-	☻ →
NCR PAPER TAPE TYPER	LOWER	TF ↓ ↓ ↓ ↓ ↓ ↓	↓ ↓ 0 ƀ PA . CL	- ↓ ↓ ↓ ↓ ↓ ↓ ↓	↓ ↓ LC UC TB CR
" " " "	UPPER	TF £ # $ % / &	* ( ) ƀ PA , CL	Δ a ↓ c d ↓ ↓ ↓	↓ ↓ LC UC CR
PDP - 1	LOWER	ƀ ↓ 2 3 4 5 6 7	8 9	0 / s t u v w x	y z .
"	UPPER	ƀ ' @ # = % ¢ ?	* (	) : S T U V W X	Y Z
705, 7080, CDC 1604		1 2 3 4 5 6 7	8 9 0 # @ TM	ƀ /	* % CM
7070 MAG. TAPE			☻ ☻	ƀ	☻ ☻ SM
1401		ƀ	☻ ☻ ↓	☻	☻ ☻ SM
1410		ƀ	: > √	¢	= ' "
650 MAG. TAPE			↓	ƀ	↓
305 RAMAC		ƀ		0	
BURROUGHS 220 P-TAPE			☻		☻
IBM 046 "			☻ ☻ →		☻ ☻ SK ☻
NCR "			¢ ↓ x (☻		+ £ w)
IBM 1620 "		↓	= ↓	↓ ↓ ↓ ↓ ↓ ↓ ↓ ↓	↓ ↓ * ↓ (
ALWAC III FLEXOWRITER	LOWER	↓ ↓ ↓ ↓ ↓ ↓ ↓	↓ ↓ a b c d e f	g h i	- j
" "	UPPER	↓ ° " + = % ? !	Σ (A B C D E F	G H I	_ J
HIDAC 101 PAPER TAPE		0 1 2 3 4 5 6 7	8 9 + - . , ( )	S A B C D E F G	H I J K L M N O
KIMBALL PUNCH TAG		TF B	7 8 9 C + Ė A D	V - ☻ ☻	F
DENNISON " "		TF ↓ ↓ A	7 8 9 - + ☻ ☻ V	B C D E	F
USS - 80		0 ↓ ↓ ↓ ↓ # +)	5 6 7 8 9 (; '	& A B C D . :	E F G H I
UNIVAC I, II		i Δ - 0 1 2 3 4	' & (	n , . ; A B C D	# ¢ @
UNIVAC III		i Δ - 0 1 2 3 4	↓ ↓ ↓ ↓ ↓ # @ (	& : ; ŏ A B C D	↓ ↓ ↓ ↓ ↓ . □ '
BENDIX G 15		☻ - CR TB ☻ ☻ . ☻	w x	0 1 2 3 4 5 6 7	8 9 u v y z
FERRANTI PROPOSAL (B.S.I.)		SP ☻ NL FF TB BS SO SI	( ) % £ ? & * /	0 1 2 3 4 5 6 7	8 9 10 11 ½ + -
RCA 501, BIZMAC		ƀ _ ‡ ¢) " : $	% ; & ' - * . CS	PC LF / 0 1 2 3 4	5 6 7 8 9 , #
BENDIX G 20 TYPEWRITER	LOWER	TB a b c d e f g	h i j k l m n o	p q r s t u v w	x y z CR BS
" " "	UPPER	ƀ A B C D E F G	H I J K L M N O	P Q R S T U V W	X Y Z | ← → ¬
GAMMA 60		ƀ A B C D E F G	H I J K L M N O	P Q R S T U V W	X Y Z . , ' ; |
FIELDATA, MOBIDIC		MS UC LC LF CR SP A B	C D E F G H I J	K L M N O P Q R	S T U V W X Y Z
IBM 7030		ƀ → ∧ ↑ ∨ ↓ > <	[ ] ← ¬ % ◊ # @	& $ * / , ' A B	C D E F G H I J
" "		± ≠ { } ⊻ ‖ ≧ ≦	⊃ ° ≡ √ \ | ! ~	+ = ( ) ; " a b	c d e f g h i

R.W.BEMER, F.A.WILLIAMS   REV. 9 OCT 1960

OCTAL



SHIFT	UNITS	MACHINE
FIG – LTR	3	C.C.I.T.T.
	3	TELETYPE
	3	FLEXOWRITER
	3	METRO-VICK 950
FIG ONLY	3	LEO
FIG – LTR	2	PEGASUS - MERCURY
	3	ELLIOTT 405
	3	B.S.I. DRAFT - MAY '59
		E.M.I. 1100, 2400
	2	PEGASUS FLEXOWRITER
	"	" "
	2	STANTEC ZEBRA
	2	E.M.I. M/C TOOL
FIG – LTR	3	ENGLISH ELEC. DEUCE
		1103A TYPEWRITER
		" "
		LGP-30 FLEXOWRITER
		" "
		RPG - 9000
		"
		RPC - 4000
		"
		LINCOLNWRITER
		"
		NCR - 304
		704, 709, 7090
		PHILCO 2000
		M-H 800
		BENDIX I/O TYPER
		RCA 301
		M-H 1000
		ALWAC III (CARD)
		BENDIX G 15 (CA-2)
		PERSEUS
	3	NCR PAPER TAPE TYPER
	"	" " " "
		PDP-1
		"
		705, 7080, CDC 1604
		7070 MAG. TAPE
		1401
		1410
		650 MAG. TAPE
		305 RAMAC
		BURROUGHS 220 P-TAPE
		IBM 046 "
		NCR "
		IBM 1620 "
		ALWAC III FLEXOWRITER
		" "
		HIDAC 101 PAPER TAPE
		KIMBALL PUNCH TAG
		DENNISON " "
		USS-80
		UNIVAC I, II
		UNIVAC III
		BENDIX G 15
		FERRANTI PROPOSAL (B.S.I.)
		RCA 501, BIZMAC
		BENDIX G 20 TYPEWRITER
		" "
		GAMMA 60
		FIELDATA, MOBIDIC
		IBM 7030
		" "

hence $\mathbf{p}_i$) is determined by

$$\mathbf{s}_i = 0 \quad \text{if} \quad f(\mathbf{p}_{i-1} + \beta_1\mathbf{h}_{i-1} + \beta_2\mathbf{r}_i) \leqq f(\mathbf{p}_{i-1})$$

$$\mathbf{s}_i = \beta_1\mathbf{h}_{i-1} + \beta_2\mathbf{r}_i \quad \text{if} \quad f(\mathbf{p}_{i-1} + \beta_1\mathbf{h}_{i-1} + \beta_2\mathbf{r}_i) > f(\mathbf{p}_{i-1}),$$

where β_1 and β_2 are scalars.

Since history may sometimes be wrong, it is important to selectively ignore it. This is conveniently accomplished by dynamic adjustments of β_1, β_2, γ_1, and γ_2. For example, whenever $f(\mathbf{p}_{i-1} + \mathbf{s}_i) \leqq f(\mathbf{p}_{i-1})$, β_1/β_2 could be tentatively increased and/or decreased to decide empirically whether more or less history is desirable. The particular algorithm described here, however, has $\beta_1 = \beta_2 = 0.5$ so that history is used in generating *every* step. γ_1 and γ_2 are dynamically adjusted so that $\gamma_1 = \gamma_2$ and $|\mathbf{h}_i| = 1$.

Algorithm 3. This algorithm coincides with algorithm 1 until N interrogations of the black box have been made. Thereafter, a model of f is derived (by a second optimizer) from the values of f that are already known. A third optimizer optimizes this model, thereby generating a position vector which is used to bias the random vectors that are used by the optimizer of f. In the simple version examined here, N is taken to be four. Each model of f is a least-squares plane fitted to the four most recently obtained values of f. This model is simple enough that the fitting was done analytically rather than by an optimizer. Assuming that this linear model is a reasonable local approximation to f, algorithm 1 is used to climb five steps on the model, using the most recent position of the f optimizer as a starting point. The resulting position vector, $\mathbf{v}_i$, is used (in this example, without modification) by the f optimizer for its next tentative position vector, i.e. $\mathbf{v}_i - \mathbf{p}_{i-1}$ is used instead of $\mathbf{r}_i$ in the formulae (of algorithm 1) that generate $\mathbf{p}_i$.

The results of applying these algorithms are shown as optimization paths in figure 5. The number of evaluations used to reach a point is given beside that point. Because the points are generated randomly, this sample is insufficient to decide—even for this problem—which of the three algorithms is superior.

REFERENCES

1. ASHBY, W. R. Design for an intelligence amplifier. *Automata Studies*, Annals of Mathematics Studies No. 34, Princeton University Press, Princeton, N. J. (1956).
2. NEWELL, A., SHAW, J. C., AND SIMON, H. A. Chess playing programs and the problem of complexity. *IBM J. Research 2*, (1958), 320–335.
3. BOX, G. E. P. AND WILSON, K. B. On the experimental attainment of optimum conditions. *J. Roy. Stat. Soc.* {B}, *13*, (1951), 1–45.
4. CURRY, H. B. The method of steepest descent for non-linear minimization problems. *Quart. Appl. Math. 2*, (1944), 258–261.
5. FORSYTHE, A. I. AND FORSYTHE, G. E. Punched-card experiments with accelerated gradient methods for linear equations. NBS Appl. Math. Series 39, pp. 55–69 (1954).
6. JOHNSON, S. M. Best exploration for maximum is Fibonaccian. U.S. Air Force Project RAND Memorandum RM-1500, Nov. 18, 1955.
7. WOLD, H. *Random Normal Deviates*. Tracts for Computers No. XXV, Cambridge University Press (1954).

Standards

Survey of Punched Card Codes

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The "Survey of Coded Character Representation" by R. W. Bemer (p. 639) covers the representation of symbols in paper tape, magnetic tape and main storage of a number of different machine systems. Another method of mechanical storage is the punched card. The results of a similar survey for punched card codes are shown in the table on page 642.

Two obvious omissions are the six-row card code of Remington Rand and the Bull code. These codes were not included because the coding techniques are entirely different from that of those shown.

The card code is identified from top to bottom by numbering the rows 12, 11, 0, 1, . . . , 9. The graphic equivalence shown is that given by printing devices in the systems. Some of the codes have a control function as well as graphic significance.

This chart is also presented as staff work for the deliberations of Sub-committee X3.2 of the American Standards Association. It is the most complete information presently available but obviously may contain errors and omissions. Any corrections or additions will be gladly received.

* * *

NOTES (to accompany table on page 642):

IBM Type Arrangements: These arrangements are the ones available upon IBM printing equipment. The F arrangement is SHARE 704 FORTRAN. The H arrangement is SHARE 709 FORTRAN.

M-H: This is the representation of the card code upon these devices when fed through the main frame.

Philco 2000: The graphics n and e print only in Memory Dump Mode.

G-15/CA-2: The manual states "all special characters."

BTM: Uses 0, 1, 6, 8 to represent O, I, G, and S.

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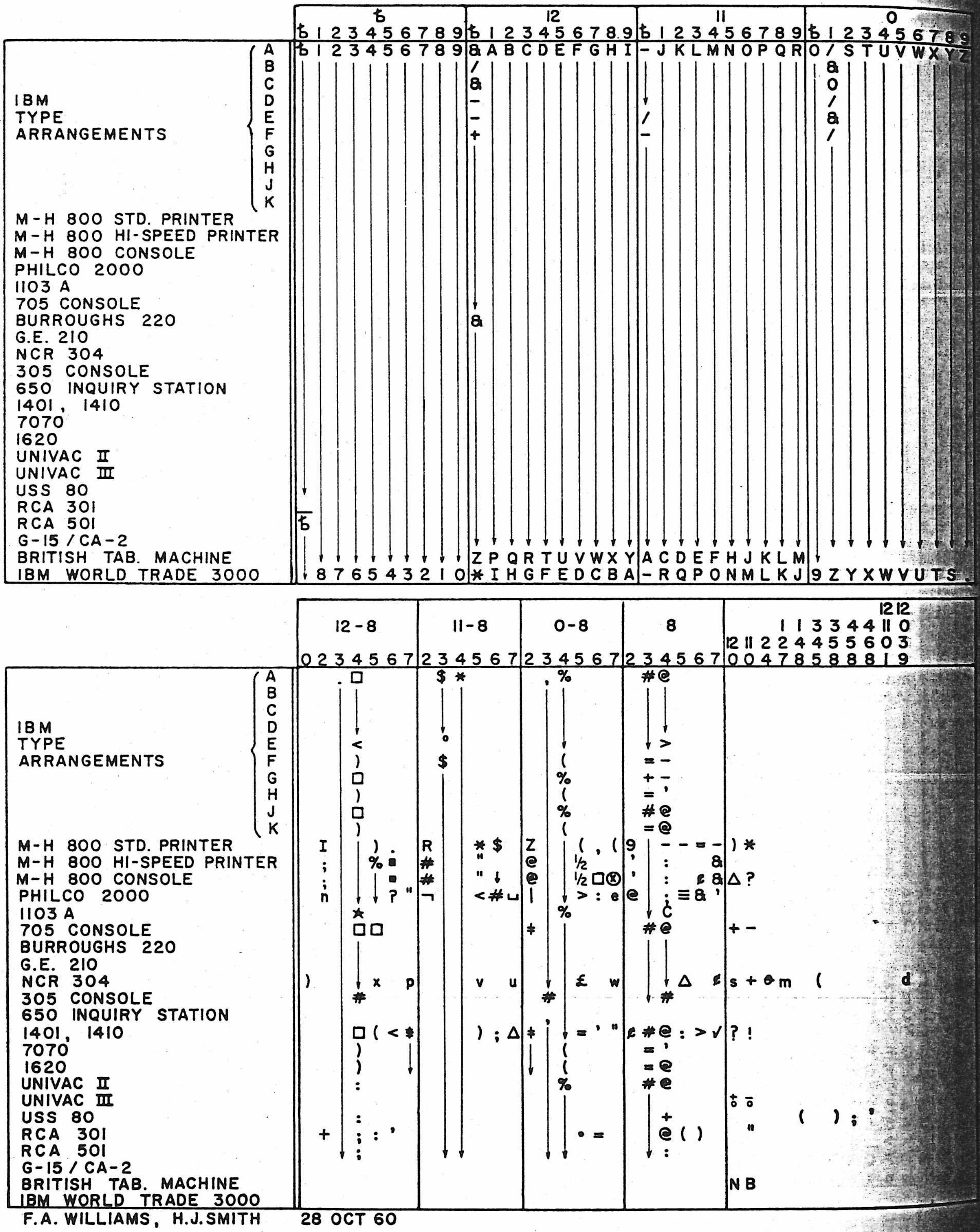
Survey of Punched Card Codes



b̸ 1 2 3 4 5 6 7 8 9 | 12: b̸ 1 2 3 4 5 6 7 8 9 | 11: b̸ 1 2 3 4 5 6 7 8 9 | 0: b̸ 1 2 3 4 5 6 7 8 9

IBM TYPE ARRANGEMENTS
A b̸ 1 2 3 4 5 6 7 8 9 & A B C D E F G H I - J K L M N O P Q R 0 / S T U V W X Y Z
B /
C & & 0
D - /
E - / &
F + - /
G
H
J
K

M-H 800 STD. PRINTER
M-H 800 HI-SPEED PRINTER
M-H 800 CONSOLE
PHILCO 2000
1103 A
705 CONSOLE
BURROUGHS 220 &
G.E. 210
NCR 304
305 CONSOLE
650 INQUIRY STATION
1401, 1410
7070
1620
UNIVAC II
UNIVAC III
USS 80
RCA 301
RCA 501 b̸
G-15 / CA-2
BRITISH TAB. MACHINE Z P Q R T U V W X Y A C D E F H J K L M
IBM WORLD TRADE 3000 8 7 6 5 4 3 2 1 0 * I H G F E D C B A - R Q P O N M L K J 9 Z Y X W V U T S .

12-8: 0 2 3 4 5 6 7 | 11-8: 2 3 4 5 6 7 | 0-8: 2 3 4 5 6 7 | 8: 2 3 4 5 6 7 | 12 11 12 0 0 4, 11 27, 12 48, 34 58, 35 58, 46 58, 12 11 0 8 1, 12 0 3 9

IBM TYPE ARRANGEMENTS
A . □ $ * , % # @
B
C
D °
E < >
F) $ (= -
G □ % + -
H) (= '
J □ % # @
K) (= @

M-H 800 STD. PRINTER I) . R * $ Z (, (9 - - = -) *
M-H 800 HI-SPEED PRINTER ; % ▪ # " @ ½ ' : &
M-H 800 CONSOLE ; ▪ # " ↓ @ ½ □ ⓧ ' : ¢ & △ ?
PHILCO 2000 n ? " ¬ < # ⊔ | > : e @ : ≡ & '
1103 A ★ % Ĉ
705 CONSOLE □ □ ‡ # @ + -
BURROUGHS 220
G.E. 210
NCR 304) x p v u £ w △ ¢ s + ⊖ m (d
305 CONSOLE # # #
650 INQUIRY STATION ,
1401, 1410 □ (< ‡) ; △ ‡ = ' " ¢ # @ : > √ ? !
7070) (= '
1620) (= @
UNIVAC II : % # @
UNIVAC III ⁺₀ ⁻₀
USS 80 : + ( ) ; '
RCA 301 + ; : ' • = @ ( ) "
RCA 501 ; :
G-15 / CA-2
BRITISH TAB. MACHINE N B
IBM WORLD TRADE 3000

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